NAVAL POSTGRADUATE SCHOOL
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THESIS

A SIMULATION OF COAST GUARD AIR SEARCH AND RESCUE OPERATIONS TO EVALUATE CERTAIN STATION LOCATION POLICIES AND SCHEMES

by

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June 1980

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A Simulation of Coast Guard Air Search and Rescue Operations to Evaluate Certain Station Location Policies and Schemes

by

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This thesis presents a simulation of air operations in the Seventh Coast Guard District which is used to investigate the effect that the relocation of Air Station Savannah will have on the Search and Rescue (SAR) system. Also examined is the probable effect that changes in the aircraft assignment policy will have on the SAR system. Representative annual case loads, generated by USCG Headquarters for the area under study, were analyzed. The thesis indicates that, under present operating conditions, the present location of the air station is better than any of the others investigated. The simulation analysis also indicates that, by separating one helicopter from the present station and relocating it elsewhere, a reduction in average response time and an increase in the percentage of cases with a response time of less than 45 minutes could be obtained. The incorporation of a new helicopter, the HH-65A, in the system was also investigated.

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I. INTRODUCTION

The United States Coast Guard (USCG) as it is known today was created in 1915 with the merger of the Revenue-Cutter Service and the United States Lighthouse and Life-Saving Service. Although a myriad of additional tasks and responsibilities have been transferred to the USCG since then, such as Maritime Inspection, Aids to Navigation, and Marine Environmental Protection, Search and Rescue (SAR) remains as the most visible and best known of the service's missions. This is only proper since a long tradition of outstanding SAR service was inherited by the USCG at the time of the merger with the Life-Saving Service. Today the Coast Guard remains the sole federal agency specifically tasked with the enforcement of marine safety and protection. It utilizes over 1600 small boats and major cutters, 140 aircraft, 200 air and boat stations, and 13,000 men and women to conduct SAR operations.

While this may appear as an extraordinary amount of SAR resources, careful observation shows that this is not the case. There are thousands of miles of coastline and rivers in the United States, along with an uncountable number of multi-jurisdictional lakes which come under the realm of Coast Guard responsibility. These vast areas now generate nearly 75,000 distress cases annually, requiring some 96,000

sorties, during which the Coast Guard is called upon to save some 4000 lives and assist in the recovery of nearly 3.0 billion dollars worth of public property [Ref. 11, pg. ES-6]. The escalating costs of today's fuel, manpower and mechanical resources, coupled with the historical 6% annual increase in SAR requirements, points out dramatically the need for optimum utilization of the above resources if the USCG is to continue to meet the demands for its services.

The Search and Rescue System is, as most policing efforts, reactive in nature. Therefore, this system must be able to move swiftly and efficiently to a distress situation because "time is the most critical element in the saving of lives and property" [Ref. 11, pg. 39].

The purpose of this thesis is to investigate the effect that certain proposed location schemes and policies will have on the response time for the air SAR system in a portion of the Seventh Coast Guard District, in the southeastern United States. At this time, Coast Guard Air Station Savannah serves the air SAR requirements of the South Carolina, Georgia and northeastern Florida area with three HH-52A helicopters. This thesis will develop and present a simulation of the current SAR system, of changes in the location of the air station and of changes in the present aircraft allocation policy of the USCG. Through the use of these simulations an improved scheme, in terms of the average

response time (ART), will be identified. It will also be shown exactly how the system will be affected by changes in the present policy of assigning no fewer than three aircraft to one location. Additionally, the incorporation of a new helicopter, the HH-65A, into the system will be investigated.

Chapter II will discuss in detail the problems that the thesis will deal with, how they originated and their relationship with the overall SAR program. Also included in this chapter will be a brief description of the present SAR system. Chapter III will contain a description of the data sets utilized in this thesis, where they came from and of how the individual cases contained therein were generated. A detailed explanation of the air SAR system model developed for this thesis and the programming assumptions made during the creation of this model are contained in the fourth chapter. The fifth chapter contains the data obtained from the runs of the computer model and an analysis of the effect upon the modeled SAR system that the location changes and aircraft scenarios had. Also included will be an analysis of the present aircraft location requirements, as set forth in Chapter II, versus the location criteria proposed by the author. The last chapter contains the conclusions and recommendations made concerning the proposed changes in station location and aircraft scenarios

II. PROBLEM STATEMENT AND DEFINITION

Nowhere is there a better example of the well-known law of diminishing returns than in the area of Search and Rescue. Given unlimited resources, both vehicular and human, the Coast Guard would possibly be able to save that last life, of all of those who survived the initial trauma of their calamity. However, the cost and amount of the additional resources needed to rescue this life would be prohibitively expensive. Therefore, SAR Program Standards have been promulgated to address this problem and to set guidelines for the acquisition and distribution of resources. Reference 11 gives a detailed account of all of the assumptions and costing mechanisms which were involved in the development of the present SAR Program Operating Plan.

The particular standard that this thesis is concerned with is the Area Coverage Standard (SAR Goal A.2.b) [Ref. 11, pg. 22, 93]. This standard requires that rescue units be located in such a manner that following the time of departure from their station they arrive on scene or in the search area within 45 minutes, for 90% of all incidents. This time (referred to as the response time for a case in this thesis) is a very important segment of the total case response time, which is defined as the time from the occurrence of an incident to the discovery of the distressed unit by the

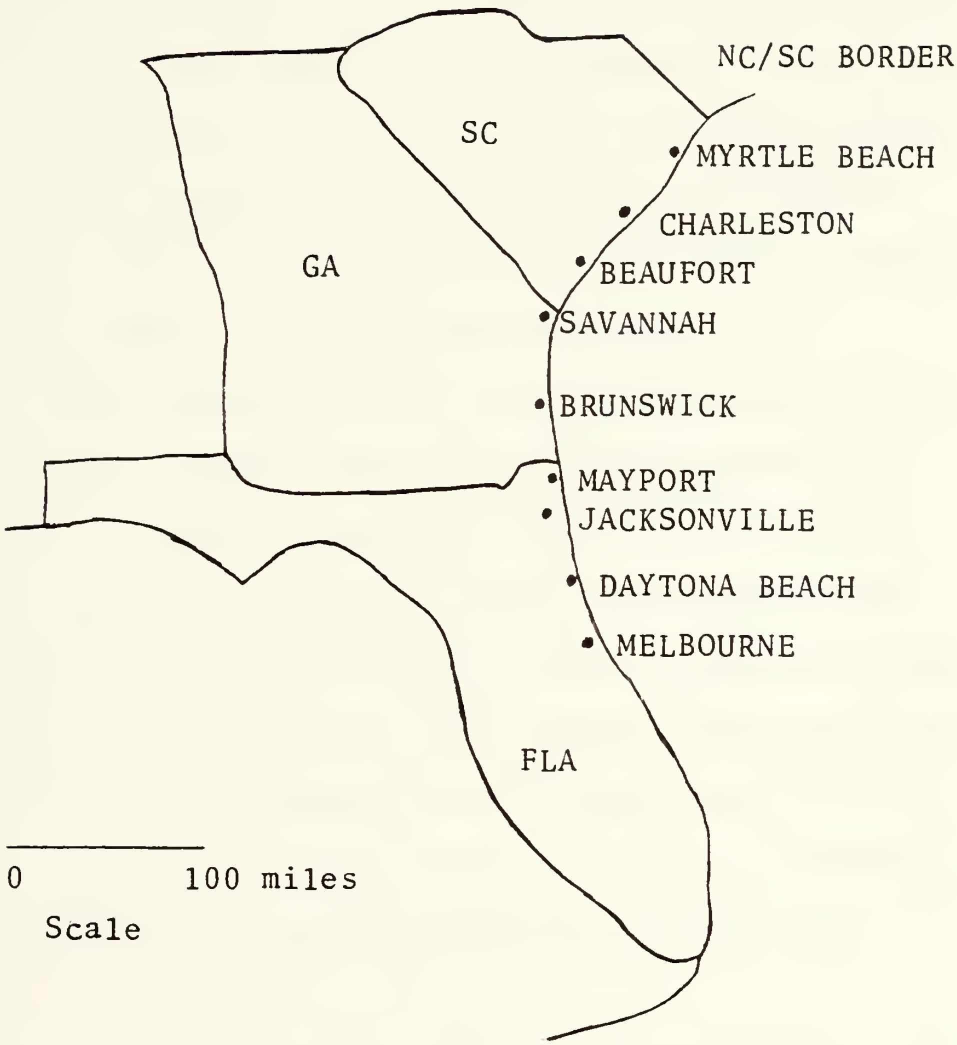
resource dispatched. The importance of this measure of effectiveness stems from the fact that the actual dispatching of rescue units entails a significant expenditure of Coast Guard resources. If these departures can continually occur from stations which are relatively close to a large majority of the cases, then the response times can be kept as low as possible.

This will result in a twofold gain for the Coast Guard, a minimizing of the total resource expenditures for SAR operations and a reduction in the total time that cases remain in a distressed situation. This latter reduction is very important because the longer a person is in a distressed situation, the greater the chance of death and, conversely, the sooner the responding unit can arrive at the scene, the greater the probability that the outcome will be of a nonsevere nature [Ref. 11, pg. 57].

Presently the USCG has one air station to serve the SAR cases which require an air resource in the coastal areas of South Carolina, Georgia, northeastern Florida and the associated inland rivers and lakes. (See Figure II-1.) This station, in Savannah, Georgia, has 3 HH-52A helicopters attached at this time. The HH-52A is an amphibious single-turbine, short-range helicopter and its major limitation is a USCG policy which will allow the HH-52A to proceed no more than 25 miles offshore due to limited engine and navigational capabilities.

FIGURE II-1

PICTURE OF THE AREA UNDER STUDY



Cases located further than 25 miles offshore are served by C-130 aircraft and for these cases which require a helicopter the C-130 will act as escort for the HH-52A. The C-130 is an all-weather, long-range aircraft, with a flight radius of 1200 miles along with 2.5 hours of on-scene search time. Air Station Clearwater, Florida, serves the majority of these C-130 requirements at this time due to its proximity to the area and its large number (4) of attached C-130s. On occasion, assistance is rendered by both Air Station Miami and Air Station Elizabeth City, North Carolina; however, for purposes of this thesis it was assumed that Air Station Clearwater provided all long-range assistance.

At this time the Coast Guard is in the process of procuring a new short-range recovery (SRR) helicopter, the HH-65A, which will be incorporated into the SAR system, eventually replacing the HH-52A as the workhorse of the Aviation Branch of the SAR system. This aircraft will have a longer range, greater speed, and, of most importance, the ability to fly as far offshore as its range limitation of 165 nautical miles will allow. This will nearly eliminate the need for C-130 assistance during short-range SAR operations.

The Seventh Coast Guard District in Miami has recently posed a few questions about the location of Air Station Savannah and its three helicopters and about the future

allocation of the new SRR units. These are:

1. Should the HH-52A units be located at Myrtle Beach, South Carolina, Jacksonville, Florida and/or Cocoa Beach, Florida?

2. Would one SRR unit provide adequate coverage for northeastern Florida and Georgia when located in or near Daytona Beach, Florida?

3. Would the present air station be more useful if it were relocated to Charleston, South Carolina, and if so would this obviate the need for an SRR unit in northeastern Florida?

These questions [Ref. 10, pg. II-16] motivate the geographic coverage question, where does the Coast Guard locate the resources that are available?

It has long been Coast Guard policy that no fewer than three aircraft will be assigned to any SAR air station. The rationale behind this policy has been that, since aircraft are also used for training, logistical support and in other mission areas, any other assignment criteria would place such a burden upon a station that the SAR mission requirements could not be adequately satisfied. This rationale is based on the "not operationally ready" (NOR) rates associated with the particular type of aircraft being studied, which are combined with the number of aircraft assigned to the unit to give probabilities of at least one aircraft being immediately available to respond to an incident. (See Table II-1.) For example, presently Air Station Savannah has three HH-52As assigned and they have an

TABLE II-1

PROBABILITY AT LEAST ONE AIRCRAFT AVAILABLE

Number of Aircraft Assigned	NOR RATE (%)				
	30	25	20	15	10
1	.7000	.7500	.8000	.8500	.9000
2	.9336	.9543	.9709	.9800	.9928
3	.9868	.9925	.9962	.9981	.9995

approximate NOR rate of 20%, so the probability that at least one HH-52A is ready to launch is 0.9962. The new SRR helicopter has an estimated NOR rate of 15% at this time [Ref. 10, pg. II-6].

After examining Table II-1, it becomes apparent that the helicopters assigned to a station are not independent entities. If this were the case, then the probability of an HH-52A being available for use, at Air Station Savannah, would be 0.992 instead of 0.9962. This additional utilization or dependency among aircraft is nearly impossible to quantify, though it is felt that most of the dependency comes from the ability of maintenance personnel to cannibalize one aircraft to obtain parts which might not normally be readily available as spares.

However, this table, developed by USCG Headquarters for use as a management tool, has been based on many years of observation of air operations and is used extensively by the Coast Guard for aircraft resource planning. For the purposes of this thesis, the NOR rates, as assigned by USCG Headquarters, and the table of probabilities were assumed to be correct. Greater detail concerning NOR rates, Table II-1, and their derivation can be found in Reference 10.

This response criteria problem was investigated at the request of the USCG Headquarters. It was approached by investigating alternatives to the present policy of three

aircraft to a station, such as single-unit stations spread out along the coast, and the impact that the NOR rates and associated probabilities from Table II-1 would have on these new location schemes.

It seemed obvious at first glance that spreading the aircraft units out along the coastline would reduce the total flight time and average response time to all cases. But would these decreases be worth the expected increase in the number of cases which would have to wait for assistance and cases where no response could be made by air resources?

The purpose of this thesis was to provide an analysis of these two problems and to make any recommendations which appear useful in answering them. Specifically, this thesis was to indicate where a good location of the assigned aircraft would be, under the present policy, looking not only at the previously discussed sites but also at all possible coastal airport sites. It was assumed that only three helicopters would be assigned to this area at any time, so the problem of how to best incorporate the new SRR units and delete the old HH-52As was to be addressed.

The SAR system for any area remains basically the same, in that discrete, random events (cases) occur and, depending on event characteristics, require service from either one or more types of rescue units. A simulation of the system was decided upon in lieu of a strictly analytical model, for these reasons:

1. There were two types of cases, search and non-search, each with separate service requirement distributions.

2. There were the three types of aircraft.

3. There exists the possibility of cases having to be deferred while waiting for an available aircraft.

4. There was a need for distributional data collection in order to compare various schemes.

5. It is able to best address the questions posed earlier as to aircraft assignment locations and the impact on SAR readiness of any splitting up of the available aircraft.

The model developed herein serves the above purposes only and is not to be construed as an attempt to augment the SARSIM model of Refs. 9, 12, 13, 14, and 15. The latter model, developed by the National Bureau of Standards and the USCG, is a theoretical model of the whole search and rescue mission area. A large, very time consuming model, it is capable of simulating completely the SAR operations for any area, under any scenario the user may wish to investigate. However, due to its complexity and associated run times, pilot studies such as this thesis are required to obtain an initial overview of this problem or scenario to see if there does exist evidence that further, more detailed investigation can be suitably justified.

III. DATA COLLECTION

Seven years of data were utilized by this thesis. The year which was labeled as one was the actual set of cases for the area of interest for FY-1979. These included all of the cases responded to by Air Station Savannah during this period. The remaining six years (labeled Year Two through Year Seven) were generated by USCG Headquarters, utilizing their SAR Data Base, for use in this thesis.

The Coast Guard has invested a large amount of money and time in this data base and it is considered to be very accurate in its ability to create a typical case load for an area of interest. Prior to this investment, a large amount of calculations and raw data collection was necessary to generate a typical set of cases for an area [Ref. 2]. Now USCG Headquarters' SAR Office maintains this data system and it is now "the primary means of collecting and storing information relative to all Coast Guard SAR operations. This system is essential in order to have a true picture of the demands placed upon the Coast Guard by SAR operations and to project these demands in terms of planning for future requirements" [Ref. 8, pg. 1-I-1].

The remaining portion of this chapter describes the manner in which the data base is maintained and how the data system actually used the data base to generate the data for this thesis.

Coast Guard Regulations require the preparation, by the responding station, of a SAR Assistance Report, CG-5151, for every case opened by that unit. Refer to Appendix A for an example of this form. These reports easily allow the quantification of all of the attributes of a case for storage in the SAR Data System. Reference 8 fully documents the preparation of the Assistance Reports and the importance to the Data Base that they have.

Any device which is used to extract information from the SAR Data Base and then to create a set of cases has to be highly accurate in its portrayal of the area's demands. To obtain this accuracy, the device used by the Coast Guard is the Search and Rescue Simulation (SARSIM) model, a part of which creates case files which are consistent and representative for an area of interest. Complete documentation and validation of the SARSIM model and this process is contained in Refs. 9, 14 and 15.

Basically what occurs is that the information extracted from the SAR Data Base is used to determine the distributions of the attributes for a typical case of an area. These distributions are then used to create cases which are compatible with the area under study, based on this historical data base. These cases are then classified in one of four ways: (1) Peak Time, Search, (2) Peak Time, Non-search, (3) Off-peak Time, Search, and (4) Off-peak Time, Non-search.

These case files are then utilized by the Originate Events Member (OEM) of SARSIM to draw a representative sample of the total caseload for the area under study. This "selection process preserves the underlying distributions of case characteristics" [Ref. 15, pg. 1].

Thus, a representative case load for a typical year, based on the historical data base for the area, could be created. Direct programmer alteration of the various "underlying distributions" can be accomplished to create various case load scenarios for atypical years when changes are expected to occur in the area. The case loads generated for this thesis were assumed to be representative of the area under study, subject to the following criteria:

1. Only cases which required an aircraft to launch were included.

2. The area of study was determined to extend south from the North Carolina/South Carolina border to Melbourne, Florida, both 100 miles inland and 500 miles offshore. This area was chosen since the NC/SC border marks the northern limit of the area of SAR responsibility for the Seventh Coast Guard District and the southern limit is the approximate northern limit for flight operations out of Air Station Miami.

3. A 6% annual growth rate in the case load was used for each succeeding year. This annual inflation of the total case load has remained rather constant for the Coast Guard since the mid-1960s and for planning purposes it has been assumed that it will continue at this rate in the foreseeable future [Ref. 11, pg. 41].

4. Due to the time constraints of this thesis and problems encountered by USCG Headquarters in generating acceptable case loads, only one case load sample for each simulated year was used.

IV. MODEL DEVELOPMENT

A. INTRODUCTION

"A simulation is a technique for conducting an experiment on a computer involving the use of a certain type of mathematical and logical model that describes the behavior of some type of system over a period of time" [Ref. 4, pg. 4]. The system portrayed in this thesis included the following basic events:

1. A case, either search or non-search, with a set of attributes occurs.

2. The type of air resource required to serve this case is identified.

These basic events were modeled by the program event routines, ENIGMA (search case) and NOSRCH (non-search case).

The next basic steps taken were:

3. The closest available aircraft of the proper type was identified and launched.

4. After proceeding via the required flight path to the area of distress or search, the aircraft remained at the scene long enough to completely satisfy the requirements of the case.

5. If the system could not respond due to all of the available aircraft being utilized, then service for the case was deferred until an aircraft became available.

These steps were modeled by the event routine LAUNCH. Then the next steps taken were:

6. When a case has been completed or aborted, then the aircraft returns back to its station.

7. Upon returning, the queue or set of cases which service for has been deferred, is checked and, if it is non-empty, then a launch is planned for the next case.

These steps were modeled by the event routine RETURN.TO.BASE.

The following sections of this chapter will discuss in detail the events just described, the remaining administrative program routines and an explanation of all mathematical and logical assumptions which were made. A slight knowledge of the SIMSCRIPT II.5 programming language will be assumed by the author in order to keep from having to go to great lengths in the explanation of certain terms that are a part of that language. Reference 3 can be utilized by the reader to obtain any detailed knowledge of the language.

B. THE PREAMBLE ROUTINE

The PREAMBLE routine was utilized to allocate storage for the events and entities and their attributes. Every air station location used in a run was modeled as a permanent entity with a location, name and various types and numbers of aircraft attached. Each air station was also assigned a set or queue which was to be used for storing cases until a helicopter was available for service. The entity CASE was used to store the attributes of each case for as long as they were needed, after which they would be destroyed.

Also included in the routine were the specifications for the statistical gathering routines. These included the

calculation of the mean and variance of the set of response times for all of the cases responded to, a histogram of these response times and the total number of cases for which a launch was made and not aborted. The number of cases responded to, a histogram of the aircraft utilizations, the number of queued cases and their waiting times, and the number of times the air station failed to launch an air resource were calculated for each air station used in the run.

C. THE MAIN ROUTINE

The MAIN routine initialized which air station/aircraft configuration would be investigated, for example, 3 HH-52As at one location, 2 HH-52As at one site and 1 HH-65A at another or possibly 3 HH-52As, each at separate locations. A completely empty, completely idle SAR system was initialized at the start of each run since an air station is not performing SAR operations for over 90% of the time.

D. THE ENIGMA AND NOSRCH EVENT ROUTINES

An event, ENIGMA for a search case or NOSRCH for a non-search case, was scheduled for each case at its system arrival time. Initially each routine read in the attributes of each case, assigned the case a number and transferred all of these attributes to a temporary entity CASE. Then it was the function of these routines to decide if the case

was reachable by a lone helicopter, or if only a C-130 was to be utilized, or if a helicopter would be needed, using the C-130 for navigational assistance. When the proper aircraft was decided upon, a LAUNCH was scheduled if needed. If the location of the case was outside of the maximum range of the helicopters in use, then a C-130 from Clearwater would serve the case completely.

The logic of handling the assignment of aircraft types and LAUNCH scheduling by these routines is best explained by considering each possible scenario separately.

Scenario 1: HH-52As only in use: If the case was greater than 25 miles offshore and the services of a helicopter were required; i.e., a medical evacuation, personnel rescue, then a LAUNCH was scheduled for the time when the C-130 was on scene to vector the HH-52A to the area. If the services of a helicopter were not needed, then a C-130 served the case and no LAUNCH was scheduled. For those cases located less than 25 miles offshore, a LAUNCH was scheduled immediately.

Scenario 2: HH-65As only in use: As long as the case was no further offshore than the maximum range of the aircraft, then a LAUNCH would be scheduled immediately. Those cases outside this range were served by C-130s.

Scenario 3: HH-52As and HH-65As both in use: If the case was located further than 25 miles offshore, then a LAUNCH would be scheduled immediately with a HH-65A as the

servicing unit. For those cases closer than 25 miles offshore, an immediate LAUNCH was scheduled but with no aircraft type specified. Then, when the closest air station to the case was determined by the LAUNCH routine, the type of aircraft which was available there would be utilized. However, if that station was unable to launch or to provide an air resource, then only the HH-65A aircraft were utilized thereafter due to the distances from one air station to another and their enhanced flight capabilities which made them the better choice.

Both of these routines performed these functions for their particular case set, but the ENIGMA routine also had to read in the total search miles for the case and account for their effect on the scheduling of the case's associated LAUNCH.

E. THE LAUNCH EVENT ROUTINE

Whenever the system was required to launch an air resource to assist or aid in the assistance of a case, the event routine LAUNCH was utilized. Using the location of the case which was associated with this launch, the routine would determine which air station was located closest to the case. These calculations were performed using Euclidian, rather than great circle, distance. Due to the relatively small distances involved and the ease in coding, efficiency is enhanced at little cost in approximation error by this choice.

Once the closest air station had been determined, it was then determined whether that air station could actually respond to the case. If all of that station's assigned aircraft were busy on other cases, then the case entered the queue if it was non-severe. For severe cases, since there existed a threat of loss of life, the next closest air station was determined. If the closest station had aircraft on the ground but none were operationally ready for SAR operations (see Chapter II) then it was assumed that the situation would not change in the foreseeable future and that all cases were referred to the next closest air station for service. Should the routine run out of air stations while attempting to launch and the case was not queued, then the case was noted as being unanswered by the system and eliminated from further consideration.

Once the closest available aircraft was located, it was assumed to have been dispatched and to have headed toward the incident location or search area via the flight path determined by the aircraft type and which of the following situations was in use:

Situation 1: HH-52A assisting a case inside of 25 miles offshore: Due to the flight limitations of the HH-52A, it was forced to travel along the coastline until the case was oriented directly seaward; then the aircraft would turn and fly directly to the case. The geographic configuration

of the coastline was depicted as shown in Figure IV-1. Any HH-52A stationed below Savannah would fly directly up along the coast, then turn right, again following the coastline. Those stationed northward would come down the opposite way. If the case was located less than 25 miles from the station, the aircraft was allowed to fly directly to the case. Also, cutting the corner at the point where the coastline turns, as shown by the dotted line in Figure IV-1, was not allowed.

Situation 2: HH-52A assisting on a case outside 25 miles offshore: Since a C-130 would already be on scene, it was assumed to be available for navigational assistance. Then the helicopter was dispatched to fly directly to the case if the location was inside the helicopter's range. For cases located outside direct flight range, the coastline flight pattern described in Situation 1 was utilized to allow the unit to refuel.

Situation 3: HH-65As serving any case: As a result of the heightened flight capabilities of this aircraft, it was able to fly directly to all cases unless this distance violated its maximum range limitation. When this violation occurred, the HH-65A was forced to follow the coastal contour flight path described in Situation 1.

While the routine LAUNCH is calculating the proper distances, it is also accounting for the miles flown or

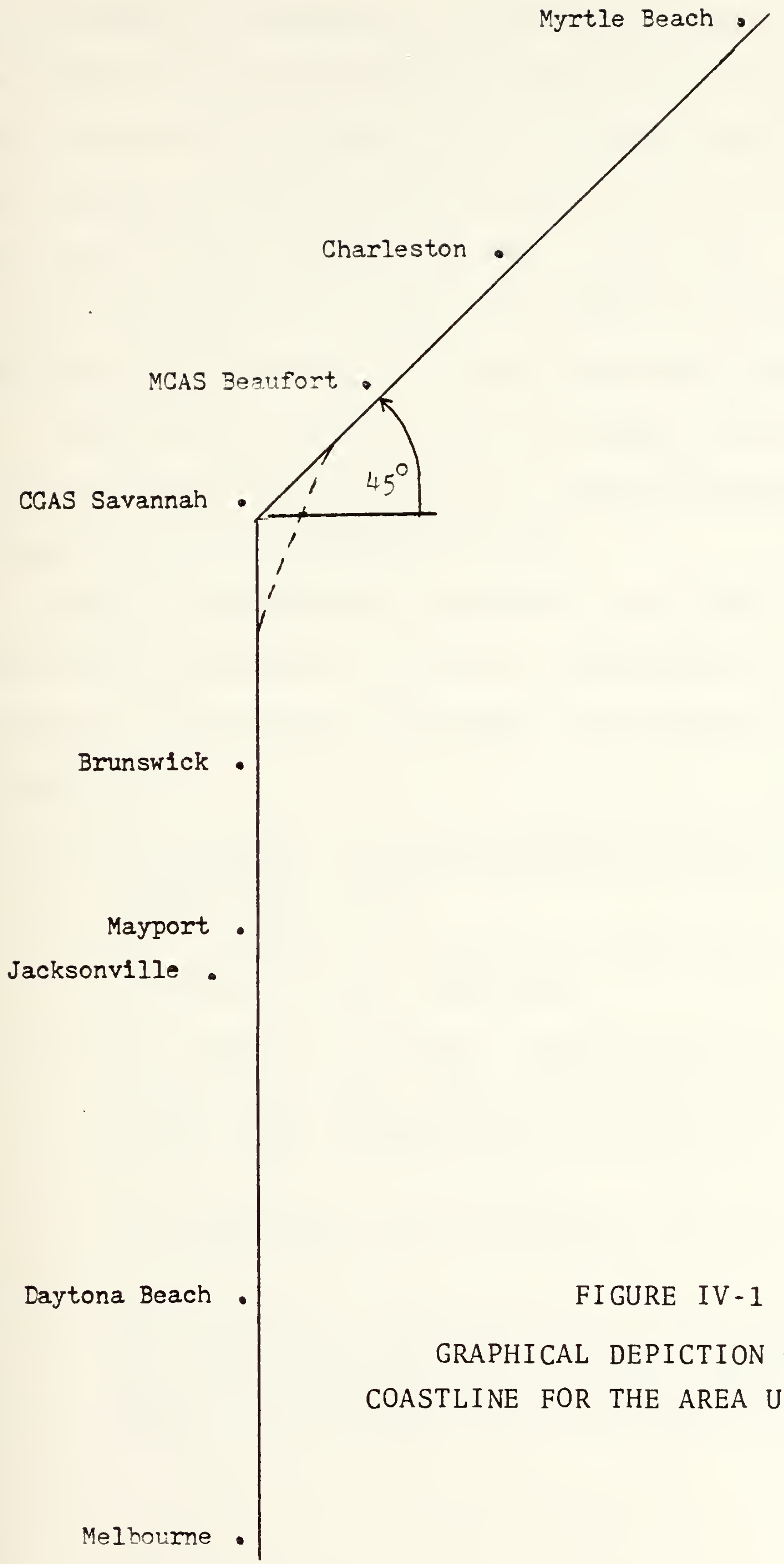


FIGURE IV-1

GRAPHICAL DEPICTION OF THE
COASTLINE FOR THE AREA UNDER STUDY

to be flown. Therefore, if the straight-line distances warranted, or if the distance along the coast and thence out to and back from the case was beyond the range of the aircraft, then a refueling stop time of one hour was added to the flight time [Ref. 2, pg. 58]. It was assumed that locations with the refueling facilities for a helicopter were readily available anywhere along the coast.

All distance calculations for flights along the coastline, as depicted in Figure IV-1, were performed by the function routine DISTANCE.TO.CASE.

Certain simplifying assumptions were made about cases and system operations during the programming of the routine LAUNCH to keep the model from becoming intractable. These were:

1. An aircraft on a case would not be diverted to another, possibly more severe, case which might have arisen.

2. The locations of all of the cases were assumed to remain constant.

3. The speeds of advance, 90 knots for a HH-52A, 140 knots for a HH-65A and 300 knots (150 knots while searching) for a C-130, were assumed to be correct and to remain constant throughout the case.

4. Once generated, the attributes of a case remained invariant throughout the case.

5. Due to the fact that for all seven years of data only ten cases occurred during periods when the visibility was less than one quarter mile, it was assumed that there were no aircraft delays in launching due to inclement weather.

F. THE RETURN.TO.BASE EVENT ROUTINE

This event routine would be scheduled to occur after an aircraft had flown out to the case location, satisfied all of the demands of the case and then returned to the air station. At this point, it was assumed that the aircraft would return along the same route that it traveled out on. Upon its return to base, the station's "queue" was checked for deferred cases and if there were any the first one was removed and scheduled for assistance in one hour. This delay is required for refueling and crew changing. If no cases were queued, then control was passed to the timing routine.

G. THE STOP.SIM EVENT ROUTINE

This event routine was purely administrative in nature. Occurring at the end of each simulated year, it printed out all of the data accumulated during the course of the run.

See Appendix B for a complete listing of the model program.

V. ANALYSIS OF THE SIMULATION DATA AND RECOMMENDATIONS

A. EXPERIMENTAL DESIGN

This thesis deals with two separate problems, that of relocating the air station to the best available location under present policy and the impact on the SAR system that changes in the present aircraft allocation policy will have. The experimental design and analysis for each problem were slightly different, as were the issues. Therefore, the plan for each experiment, the issues being questioned and how the analysis was carried out are all described for each problem in that problem's section introduction.

B. LOCATION OF AIR STATION SAVANNAH UTILIZING CURRENT USCG POLICY

1. Introduction

Policy now in effect requires that all three helicopters in the system be stationed together at a single base. To investigate just where this station should be located, the following design was utilized.

1. An initial run, in which all three helicopters in the system were assigned to each possible air station site, was performed.

2. The FY-1979 case load was utilized for every location, using the same random number seed so that the variance reduction technique of correlated samples was implemented for each run.

3. Those locations which, based upon the initial results, appeared to be impractical were eliminated from further investigation. These locations were chosen arbitrarily by the author in order to keep the total number of runs made as low as possible. Since a run for each year's case load used from 55 to 75 seconds of computer CPU time, six additional runs for a location which appeared to be a very poor alternative were avoided.

4. For those locations which appeared to be viable alternatives, subsequent runs utilizing all six years' case loads were made and the results reported.

By utilizing this design, it was shown where the best location of the three helicopters would be for each system.

2. <u>The 3 HH-52A System</u>

The results of the initial run for this system are given in Table V-1 where ART = average response time for a case; SDRT = standard deviation of the set of response times for a year; % < 45 = percentage of that year's cases with response times less than 45 minutes; and % ≥ 120 = percentage of that year's cases with response times greater than 120 minutes.

The values given in Table V-1 and all subsequent tables are for one run only. Replications of one scenario were done only for Savannah (10 replications) and then Charleston and Mayport (3 replications each). The ranges between the high and low values obtained were 2 minutes for ART, 1.5 minutes for SDRT and 1% for the two percentages

TABLE V-1

3 HH-52As in One Location, Initial Run

Location	ART	SDRT	% < 45	% > 120
Myrtle Bch	119.89	79.67	4.6	24.6
Charleston	74.88	62.36	26.2	17.7
MCAS Beau.	56.62	50.00	61.5	17.7
Savannah	48.38	45.48	60.0	12.3
Brunswick	52.66	28.41	47.7	3.1
Mayport	66.19	21.83	12.3	0.7
NAS Jacksv	69.29	22.67	13.8	1.5
Daytona Bh	92.18	43.40	18.5	23.1
Melbourne	120.22	62.50	16.2	64.6

reported. These small ranges result from the low stochastic nature of this simulation. So when very large values were obtained, such as those for Myrtle Beach or Daytona Beach, the author would not consider that location any further.

It is obvious that this process is not supported by any statistical theory and could be a source of criticism. However, some way had to be decided upon to keep the number of runs to a reasonable level and, even with the use of this process, over 200 runs were still required, using over three hours of CPU time. The final reasoning behind this method of location reduction was that the location of an air station at a site where there was a possibility of getting unacceptable values, such as the ones obtained, would probably not be a viable alternative to the decision maker.

Location of air stations at Myrtle Beach, Beaufort, Daytona Beach or Melbourne was given no more consideration due to excessively large values of ART, SDRT or case percentages when compared to Savannah. Location at Jacksonville was eliminated in favor of Mayport since they are located close together but Jacksonville is an area of high air traffic density while Mayport has very little traffic and is located very close to the shoreline. Jacksonville was included on the remaining initial runs though to ensure that no large gains in system efficiency would be overlooked.

Location of an air station at Brunswick received further consideration, but only one run for each year's case

load was performed. This was done since Brunswick is located very close to Savannah and it appeared that the move of a complete air station over that small a distance probably could not be justified.

Location of an air station at Charleston, which appeared to be a poor proposition, was given a complete analysis anyway since it is to here that the Seventh Coast Guard District has proposed to relocate Air Station Savannah.

Location at Mayport received a complete analysis due to its distribution of initial run response times which was very dense about the mean and, as a result, it had only one case with a response time greater than 120 minutes. Of course, in opposition to this figure, there were fewer cases with response times less than 45 minutes.

Air Station Savannah was given a complete analysis so as to have a basis for comparison for the alternative locations. The figures obtained from the complete analysis, utilizing seven years of cases and three replications for each year, are given in Appendix D.

Observation of the data indicated an increase in total system case load from 139 to 178 cases, attributable to a 6% annual increase in case load, with no marked increasing trend in the average response time of the system. Also, there were very few cases, six, that had to be queued while waiting for service. Since the preceding points remained true no

matter which location was used, it seems reasonable to assume that this system should remain stable in the near future under present Coast Guard policy. Therefore, any perturbations in the system will have to be judged by their effects upon the ART of the system and by their degree of compliance with the applicable SAR Program guidelines, as promulgated by USCG Headquarters.

The sample data obtained showed that the range of response times for the present system, for all seven years, is from 38.6 to 50.87 minutes, with an overall average of 45.8 minutes. Relocating Air Station Savannah to Charleston had the effect of increasing the range of response times to 69.31 - 80.42 minutes, with an overall range of 75.48. This move also increased the SDRT from an overall value of 44.88 minutes to one of 60.69 minutes. The percentage of cases with a response time of less than 45 minutes was reduced from an average of 64% to 24.2% for each year. The move also increased the percentage of cases with times greater than 120 minutes from an average of 11.6% to 17.0% per year. Therefore, a relocation to Charleston is not recommended.

The other locations studied, Brunswick and Mayport, appear to be much better locations than Charleston but not so much so that a shift from Savannah could be recommended. Mayport did have a very low percentage of cases with times greater than 120 minutes, less than 1.5% for every year

except one. However, this advantage was offset by its low percentage (15.3%) of cases with a response time of less than 45 minutes, which caused it to have an overall ART of 64.78 minutes.

The Brunswick location appeared to be the most promising, if a relocation was to take place. Brunswick had a comparable overall response time of 50.55 minutes, with a SDRT of 28.43 which was much lower than Savannah's 44.88. However, the situation here is similar to the one just described for Mayport in that Brunswick had very few cases with response times larger than 120 minutes (4.1% overall) but its slower response to the remainder of the case load results in a larger ART and an overall weaker performance than Savannah.

In conclusion, as long as the Coast Guard is going to maintain its current SAR air rescue allocation policy, in that no fewer than three aircraft will be assigned to any one location, no relocation of the air station servicing this portion of the Seventh Coast Guard District is recommended.

3. The Incorporation of the HH-65A into the System

Incorporation of new HH-65A aircraft in the system under present allocation policy is superficially a trivial problem. The oldest, or most unreliable, of the remaining HH-52As would be replaced by the new incoming craft and the

station would remain where it was before, still with three helicopters assigned.

However, the possibility exists that the new aircraft's increased capabilities could result in an alteration of the system's response attributes which could indicate that a move of the station could now be justified.

To investigate this possible situation, an initial run, similar to the one performed for the "3 HH-52A system," was executed for the 2 HH-52A/1 HH-65A system. The results for the run, which are tabulated in Table V-2, are remarkably similar to those obtained for the 3 HH-52A system previously discussed. The major difference is that nearly every table value has increased, but in such a way that the ordering precedence has been preserved. By ordering precedence, it is meant that Savannah's ART is lower than Beaufort's, which is lower than Charleston's, and so on. This increase for the ART and SDRT occurs even though the new aircraft is more capable because of the additional 12-19 cases served yearly by a 140-knot, short-range helicopter, which were previously serviced by a C-130, a 300-knot, long-range aircraft. These cases are located further offshore than the other cases, thereby causing the overall increase in the ART and in the SDRT.

It was felt that surely, as more of the newer aircraft are integrated into the system, the response times

TABLE V-2

2 HH-52As and 1 HH-65A in One Location, Initial Run

Location	ART	SDRT	% < 45	% > 120
Myrtle Bch	129.54	106.26	6.1	25.4
Charleston	82.06	97.71	29.2	20.0
MCAS Beau.	63.73	92.01	64.6	18.5
Savannah	55.07	91.24	61.5	13.8
Brunswick	58.56	82.55	50.7	3.8
Mayport	73.30	79.14	13.8	1.5
NAS Jacks.	76.84	79.00	13.8	1.5
Daytona	100.80	84.99	18.5	23.1
Melbourne	131.90	92.49	16.2	68.5

would again decrease to their original levels or less. Therefore, the final configuration of 3 HH-65As comprising the system aircraft was simulated, utilizing the same conditions as used on the previous runs, and these results are compiled in Table V-3.

As expected, all of the table values were found at their lowest levels except for the percentages of cases with a response time of less than 45 minutes, which were at their highest.

In conclusion, since all of the numerical orderings remained basically the same as those investigated in Section B.2 of this chapter, no relocation of the system's air station is recommended when the incorporation of the new aircraft into the SAR system begins.

C. REDEFINITION OF THE CURRENT COAST GUARD AIRCRAFT ALLOCATION POLICY AND ITS IMPACT ON THE SAR SYSTEM

1. Introduction

This section of the thesis dealt with the influence that changes in the current policy of assigning no fewer than three aircraft to any one station would have upon the SAR system.

It was hypothesized that, given a limit of only three aircraft in the system, much lower response times could be obtained by spreading these resources out along the coast and dispatching the closest available unit to all distress

TABLE V-3

3 HH-65As in One Location, Initial Run

Location	ART	SDRT	% < 45	% > 120
Myrtle Bch	84.53	85.85	14.6	21.5
Charleston	55.78	85.84	67.7	10.0
Beaufort	44.79	85.80	73.8	1.5
Savannah	40.39	84.71	74.6	1.5
Brunswick	43.67	80.17	66.2	0.8
Mayport	52.61	78.22	55.4	0.8
NAS Jacks.	55.69	78.01	37.7	0.8
Daytona	72.83	78.76	20.0	1.5

situations. The type of system envisioned here is one which would be analogous to the type of arrangement currently utilized by the various Coast Guard Groups. These units are allotted a certain number of boats and personnel which are in turn distributed among the stations of the Group which are located throughout the Group's area of responsibility.

Reference 10, during its discussion of the NOR rates and their use, details a few of the objections to a policy of this type, but no quantitative support is presented. Therefore, it may be possible to show that, even though a few additional cases may be queued or forced to go without an air resource (thereby having to be served by slower surface craft), the benefits to be reaped in terms of reduced total flight time and time that situations remain in a distressed status may very well overcome previously held misgivings concerning this type of policy.

At an early stage, it became quite evident that due simply to the sheer number of possibilities there was no way to investigate all of the acceptable combinations of air station locations and numbers of assigned aircraft. Therefore, with the use of the results obtained in Section B of this chapter, some simplifying assumptions were made in order to make the number of possible scenarios more tractable. They were:

1. Due to the facilities presently available and the fact that it was shown to be the

most desirable location, there would always be at least one aircraft located in Savannah.

2. When there were two aircraft assigned together, they would be located in Savannah.

3. When the integration into the system of the HH-65A was investigated, only one helicopter was considered since the projected delivery date of subsequent aircraft (mid-1980's) to the system postdates the available data base by such a margin as to render any results obsolete.

4. Due to the fact that even when the new helicopter is assigned to the system with two HH-52As, the two groups remain independent of each other in regards to their operational readiness probabilities, it was assumed that the two HH-52As would remain together and the HH-65A would be separated. Assumption 4 appeared reasonable because of the maintenance savings which would be made by having to support only two, in lieu of three, maintenance/spare parts operations for the system.

By utilizing these assumptions, in conjunction with an experimental plan similar to that described in Section B.1 of this chapter, it was shown what the impact on the SAR system would be by the adoption of this type of allocation policy.

2. <u>The 3 HH-52A System</u>

The first configuration investigated was that of removing one HH-52A from Savannah and relocating it at various other locations in the area. As was done in previous trials, an initial run was performed to reduce the number of possible locations. The results of this run, which utilized the data generated for the first year, are given in Table V-4.

TABLE V-4

Initial Run Data

2 HH-52As in Savannah and 1 HH-52A in Various Other Locations

Location	ART	SDRT	% < 45	% > 120	# Queued
Charleston	37.79	37.89	65.9	6.8	1
MCAS Beau.	38.49	37.91	68.7	6.8	1
Brunswick	31.23	29.84	74.6	3.8	1
Mayport	31.23	25.62	73.3	1.5	0
Daytona	31.66	27.96	73.3	1.5	0
Melbourne	36.87	31.77	69.8	4.2	0

Location of the separated helicopter at either Charleston, Beaufort or Melbourne was not given any further consideration. This was due to their excessively large ART and SDRT values and their smaller percentages of cases with response times less than 45 minutes, when compared to the remaining locations. Since these other three locations, Brunswick, Mayport and Daytona Beach, all exhibited an initial decrease of nearly 20% in the ART for the system and an increase from 68% to over 73% in the percentage of cases with a response time of less than 45 minutes, they were chosen for further study. The results of the complete analysis performed for the three locations are compiled in Appendix E.

Of the three locations studied, Daytona Beach was clearly superior. Its ART was consistently lower and it had the smallest statistical range, with an overall average of 34.04 minutes versus 36.16 for the Mayport and 38.02 for Brunswick. The percentage of time Savannah had at least one helicopter available for services other than SAR remained rather constant at approximately 99.85% for all three locations, while the percentage of time the lone HH-52A was away was the lowest for Daytona Beach (1.5% versus 1.9% and 2.1% for Mayport and Brunswick, respectively). Daytona also had the highest overall percentage of cases with response times lower than 45 minutes, 71.6%, more than 4% better than

either of the others and its worst year's value of 66.5% compared very favorably to the 60.1% and 61.5% obtained for the other two. In the area of cases queued, Daytona was once again the best alternative with a total of 10 cases queued versus 15 and 16 cases for the others, over all seven years. It was in this area that Daytona's only drawback was observed, in that the cases queued, while fewer in number, had a longer average waiting time than those in the other two queues. So if a scenario such as this one, two stations and three HH-52As, is to be utilized, then the recommended configuration under Assumption 2 is to have a dual-helicopter station in Savannah and a single-unit station in Daytona Beach.

Now the pertinent question to be addressed is: What will the gains be, in terms of increased efficiency in SAR system operations, for the USCG? By comparing the data compiled in Appendix E for the Daytona system to that listed in Appendix D for the present system, it was found that:

1. Each year's ART was decreased by this new scheme, with a minimum decrease of 7.5 minutes (19%) for Year 2, to a maximum decrease of 14.8 minutes (31%) for Year 5, with an overall average decrease of 11.6 minutes (25%). In addition to reducing the probability of a case having a critical outcome, these lower ARTs also translate into an approximate reduction of 29 hours of system flight time per year.

2. Each year's percentage of cases with low response times increased, with a minimum

increase of 5% for Year 2, to a maximum of 11% for Year 5, with an overall increase of 8%, or from 63.5% to 71.6%.

3. The percentage of time that Air Station Savannah had a helicopter available for non-SAR use remained well over 99% for both situations, while Daytona's percentage was better than 98% for every year except Year 7, which had a value of 97.9%.

4. The two-air-station configuration had a larger number of cases which had to be queued, 10, than did the present system which had only one. This was expected since, when a non-severe case occurs and the closest available air station does not have an air resource available at that time which will occur more frequently during this scenario, then the case is queued until the return of a helicopter.

So by adopting a system of this type, the Coast Guard can obtain a reduction in the amount of total flight time for this area and in the ART for a case located in this area. This adoption will increase the number of cases with low response times and still maintain an available helicopter for over 98% of the time, at <u>both</u> air stations. To see if even greater increases in system efficiency could be obtained by splitting up all three helicopters and placing them all in separate locations, an additional run was performed, subject to the assumptions made earlier in this chapter, utilizing the same data as before, for ten location schemes. The pairs of locations used, in addition to Savannah, and the results obtained are tabulated in Table V-5. As can be seen, the ARTs are all higher than those obtained in the

TABLE V-5

Initial Run Data

1 HH-52A in Savannah and 1 HH-52A in Each of
Two Other Different Locations

Location Pair:	ART	SDRT	% < 45	% > 120
Beau/Brun	41.17	41.34	76.5	10.6
Beau/Mayport	41.11	38.84	69.7	8.3
Beau/Char	48.60	53.99	66.6	15.2
Beau/Daytona	39.56	40.09	72.7	9.8
Brun/Char	42.40	45.32	66.6	10.6
Brun/Mayport	40.04	31.83	58.3	2.3
Brun/Daytona	37.90	33.32	62.9	3.8
Char/Mayport	42.32	40.00	58.3	6.1
Char/Daytona	42.33	44.58	64.4	9.8
Mayport/Daytona	40.68	31.16	53.6	3.0

preceding system (Table V-4) and the percentages of cases with response times less than 45 minutes were all lower than those of the previous system. In fact, these values are for the most part worse than those which were obtained for the present system, and this type of location scheme was not investigated any further in this thesis.

Initially these results were perplexing because it seemed intuitive that the ARTs would decrease with such a spread of air resources. Closer scrutiny showed what was occurring was that with three single-unit stations many cases, particularly the higher severity ones, which were located very close to one air station were forced to obtain service from other stations, which were increasingly further away. This was due directly to the relatively low probabilities of a single helicopter being available for SAR operations that every station now had. Therefore, this search for an available server pushed up the ART to the levels indicated, making this scenario a very poor alternative to even the present system.

3. The 2 HH-52A/1 HH-65A System

In recognition of Assumptions 3 and 4, of Section C.1 of this chapter, when this system was investigated, only the scenario which had two HH-52As located in Savannah and the new helicopter located in various other places was investigated. So for comparison purposes, it was first required

that a complete analysis for this system be performed which had all three helicopters located in Savannah. The results of this analysis are tabulated in Appendix F.

Then an initial run was made, utilizing the FY-79 case load of Air Station Savannah (Year 1). The results of this run are compiled in Table V-6. Here again, as in the previous section, the possible relocation sites decided upon were Brunswick, Mayport and Daytona Beach, due to their overall superiority to the remaining locations. The results obtained from the complete analysis of the three locations selected are presented in Appendix G.

Among the locations studied, no clearly better alternative could be identified. All three systems seem to operate in such a manner that all of their ARTs, SDRTs and case percentages remained very close to each other. The ARTs for each year were always very close, differing only by 2.5 minutes or less for every year except 2 and 3, which had a total difference of six minutes each. As for the overall ART, it ranged from 38.03 for Mayport, to 38.3 for Brunswick, to 39.12 for Daytona Beach. The percentage of time Savannah had at least one helicopter available was 99.5% for every year and location, while the same percentage for the HH-65A remained above 97.0% for every year, with an overall average of 97.4% for Brunswick and Mayport and 97.9% for Daytona Beach. Daytona also came out slightly ahead in regards to

TABLE V-6

Initial Run Data

2 HH-52As in Savannah and 1 HH-65A in Various Other Locations

Location:	ART	SDRT	% < 45	% > 120
Charleston	49.96	90.75	75.2	15.5
Beaufort	49.81	91.00	74.4	14.7
Brunswick	41.48	83.82	67.4	4.6
Mayport	41.31	81.89	66.6	2.3
Daytona	40.69	82.69	73.6	2.3
Melbourne	45.82	85.55	67.4	5.4

the values obtained for the percentage of cases with response times less than 45 minutes. It had a minimum value of 70.5%, a maximum of 80.7%, with an overall average of 75.1%, while Brunswick had a minimum of 65.1%, a maximum of 79.3% and an overall of 71.5%, and Mayport had a minimum of 66.6%, a maximum of 78.6%, with an overall average of 72.7%. The percentages of cases with response times greater than 120 minutes were very close, remaining at approximately 3% for all seven years, at all locations.

As for the number of cases queued, it was again very close, with Brunswick having seven cases queued and Daytona and Mayport having nine and 12 cases queued, respectively. Additionally, there did not appear to be any major differences in the total waiting time for the cases among the three locations.

Selecting a location for this system for an initial relocation would require additional study in areas such as available facilities at certain locations or in possible changes in the attributes of the projected case load for this system's region of responsibility. However, if a relocation had already been accomplished, such as the one recommended in Section C.2 of this chapter, then the separated HH-52A could easily be replaced by the new HH-65A, for a more efficient system.

By comparing the data in Appendix G to that tabulated in Appendix F, an indication of just how much more efficient

this proposed system would be to the present one can be obtained. Through this comparison, it could be seen that:

1. The overall ART for the system would decrease by 13-14 minutes, approximately 24%, with similar decreases in each year's ART.

2. The percentage of cases with response times less than 45 minutes would increase from a yearly average of 66.27 to at least 71.5% and possibly even 75.1%.

3. The percentage of cases with response times greater than 120 minutes would decrease from a yearly average of over 13% to one of approximately 3%.

4. Every air station location, no matter what the scenario, would have at least one helicopter available for use in mission areas other than SAR for over 97% of the year.

The Coast Guard can probably obtain large increases in the numbers of cases with small response times, decreases in the ART for a case during a year, decreases in total yearly flight time and a decrease in the percentages of cases with response times greater than 120 minutes by adopting the type of allocation policy and system proposed in Section C.1 of this chapter. These increases are also obtained without seeming to place an unusual burden upon any air station's ability to meet its other mission area demands since an aircraft is available for use over 97% of the time throughout the year.

VI. CONCLUSIONS

If the Coast Guard continues to adhere to its present aircraft allocation policy of three units to a station, then it has been shown that the present system is acceptable in terms of average response times and total flight time. It was also shown that the present system is acceptable in that it came the closest of any of the simulated air station locations to complying with SAR Program Goals, as promulgated by Ref. 11. Any relocation of the three-helicopter station, such as to Charleston, South Carolina, is not recommended since this resulted in a degraded system and would entail the expense of relocating an entire station.

All of the results obtained in the second portion of this thesis are presented as information for the decision maker. This information indicates that changes in the present policy of three aircraft to a station can result in better performance standards for the station's area of responsibility.

In particular, for Air Station Savannah, it was shown that, by relocating one helicopter, an improved system was attainable. However, when the units were separated into three single-unit stations along the coast, the inability of the stations to make consistent responses to a majority of their cases resulted in an overall degraded system.

APPENDIX A

COAST GUARD ASSISTANCE REPORT (CG-5151)

RCS-G-OSR 2000

DEPARTMENT OF TRANSPORTATION U S COAST GUARD CG 5151 (4 78)	SEARCH AND RESCUE ASSISTANCE REPORT	CASE NO
REPORTING UNIT	NAME OF ASSISTED UNIT	REGISTRATION NO *(Optional)*
A. IDENTIFICATION DATA SECTION	REMARKS	NAME/ADDRESS OF OWNER/OPERATOR

A. IDENTIFICATION DATA SECTION

A01		A02	A03	A04	A05
DS	OPFAC	UCN	MUCN	MON/YR NOTIF	# SORTIES/ RESPONSES
1	2 3 4 5 6 7	8 9 10 11	12 13 14 15	16 17 18	19 20

B. CASE DATA SECTION *(For Multi-Unit Cases, only SMC will complete this section)*

CARD CODE	B01	B02	B03	B04	B05	B06		B07		B08	B09	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21
CARD CODE	DAY/TIME CG NOTIFIED	TIME FROM OCC TO NOTIFICATION	METHOD OF NOTIFICATION	NATURE	DISTANCE OFF SHORE	LATITUDE	N/S	LONGITUDE	E/W	METHOD OF LOCATING	INITIAL SEVERITY	ACTUAL SEVERITY	CAUSE	OWNERSHIP	USAGE	PROPULSION	LENGTH	DAY/TIME LOCATED	LIVES LOST	LIVES SAVED	PERSONS OTHERWISE ASSISTED	PROPERTY LOST	PROPERTY ASSISTED
21	22 23 24 25 26 27	28 29	30 31	32 33	34	35 36 37 38	39	40 41 42 43 44	45	46 47	48	49	50	51	52 53	54	55	56 57 58 59 60 61	62 63 64 65	66 67	68 69 70	71 72 73 74 75	76 77 78 79 80
2																							

C. SORTIE DATA SECTION

CARD CODE	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14	C15	C16	C17	C18
CARD CODE	DAY/TIME UNIT NOTIFIED	CASE STATUS	SORTIE NUMBER	ASSISTING RESOURCE TYPE	STAND-BY RESOURCES	DAY/TIME UNDERWAY	DISTANCE TO SCENE	TIME SPENT SEARCHING	DAY/TIME FIRST RESOURCE ALONGSIDE	TIME ON SCENE	TIME ON SORTIE	SEA CONDITIONS	WIND	VISIBILITY	ASSISTANCE RENDERED	SORTIE ABORT	MISSION PERFORMANCE	(OPTIONAL) SPECIAL STUDIES
21	22 23 24 25 26 27	28 29	30 31	32 33	34	35 36 37 38 39 40	41 42 43	44 45 46	47 48 49 50 51 52	53 54 55	56 57 58	59 60	61 62	63	64 65 66 67	68	69 70 71 72 73 74	75 76
3																		

(FOR KEYPUNCH ONLY)

DUPLICATE CARD COLUMNS 21-29 OF ABOVE RECORD FOR ALL REMAINING COMPLETED RECORDS

DATE		
SIGNATURE		
COMMAND LEVEL	UNIT	GROUP

THIS FORM REPLACES CG 3272 AND CG 3272A
SN 7530-01-GF2-8340

DISTRICT COPY

____ of ____

APPENDIX B

COMPUTER PROGRAM

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PREAMBLE....

NORMALLY MODE IS REAL
EXTERNAL EVENT UNITS ARE 1 AND 2
EXTERNAL EVENTS ARE ENIGMA AND NOSRCH
EVENT NOTICES INCLUDE STOP.SIM ....
    EVERY ENIGMA HAS A SSEAS, A SWINDS, A SVIS, A SSEV, A SR.LNG,
        A SR.LAT, A SDOS, A SNOM1, A SSER.1, A SNOM2, A SSER.2,
        A SNOM3, A SSER.3, A STSEM
    EVERY NOSRCH HAS A NSEAS, A NWINDS, A NVIS,A NSEV, A NLONG,
        A NLAT, A NDOS, A NNOM1, A NSER.1, A NNOM2, A NSER.2,
        A NNOM3, A NSER.3
        DEFINE SNOM1, SNOM2, SNOM3,   NNOM1, NNOM2, NNOM3
        AS ALPHA VARIABLES
        DEFINE SSEV, NSEV
        AS INTEGER VARIABLES
    EVERY LAUNCH HAS A SORTIE
    EVERY RETURN.TO.BASE HAS A STATION AND A RETURNING.TYPE
        DEFINE RETURNING.TYPE AS AN INTEGER VARIABLE
        DEFINE STATION AS AN ALPHA VARIABLE
PERMANENT ENTITIES ....
    EVERY AIR.STATION HAS AN AS.LAT, AN AS.LONG, A NUM.HH, A
        NUM.MRR, A NAME, A CASE.COUNT, A LNG.MULT, A STATUS,
        AN AC.ATT.STATUS, A NO.HH.LAUNCH, A NO.MR.LAUNCH, A
        WAIT.TIME AND OWNS AN AS.QUEUE
            DEFINE NAME AS AN ALPHA VARIABLE
            DEFINE NUM.HH, NUM.MRR, STATUS, CASE.COUNT,
            AC.ATT.STATUS, NO.HH.LAUNCH, NO.MR.LAUNCH
                AS INTEGER VARIABLES
TEMPORARY ENTITIES ....
   EVERY CASE HAS A CASE.NUM, A SEAS, A WINDS, A VIS, A SEV,
```

```
          A LONG, A LAT, A DOS, A TSUM, A NOM1, A SER.1, A NOM2,
          A SER.2, A NOM3, A SER.3, A TYPE, AN AC.TYPE, A
          TIME.IN.QUEUE AND MAY BELONG TO AN AS.QUEUE
              DEFINE NOM1, NOM2, NOM3
                  AS ALPHA VARIABLES
              DEFINE CASE.NUM, SEV, TYPE, AC.TYPE
                  AS INTEGER VARIABLES
              DEFINE AS.QUEUE AS A SET RANKED BY HIGH SEV
ACCUMULATE MR.GRAPH(0 TO 3 BY 1) AS THE HISTOGRAM OF NUM.MRR
ACCUMULATE HH.GRAPH(0 TO 3 BY 1) AS THE HISTOGRAM OF NUM.HH
TALLY AVG.WAIT.TIME AS THE MEAN, VAR.WAIT.TIME AS THE VARIANCE,
    SD.WAIT.TIME AS THE STD.DEV  AND NUM.WHO.WAITED AS THE NUMBER
    OF WAIT.TIME
TALLY AVG.RESP.TIME AS THE MEAN, VAR.RESP.TIME AS THE VARIANCE,
    SD.RESP.TIME AS THE STD.DEV, ANSWERED.CASES AS THE NUMBER AND
    RT.GRAPH(0 TO 2 BY .05) AS THE HISTOGRAM OF RESPONCE.TIME
  GLOBAL VARIABLES ....
DEFINE DISTANCE.TO.CASE AS A REAL FUNCTION
DEFINE RESPONCE.TIME, HH.SPEED, HH.RANGE, HH.ENDUR, MRR.SPEED,
    MRR.RANGE, MRR.ENDUR, DIST.TO.CASE, DIST.FM.AS
    AS VARIABLES
DEFINE CLOSEST.AS
    AS ALPHA VARIABLES
DEFINE X.NUM, MR.FLAG, C130.CALLS, NO.RESPONCE.CASES, HH.FLAG,
    ABORTED.CASES, SORTIE, SEED
    AS INTEGER VARIABLES
END


ROUTINE DISTANCE.TO.CASE


LET CUTOFF = 32.1/57.29577
FOR EACH AIR.STATION WITH NAME(AIR.STATION) EQ CLOSEST.AS, DO
IF LAT(CASE) LT CUTOFF AND AS.LAT(AIR.STATION) LT CUTOFF
    LET KNOTS.UP=ABS.F((AS.LAT(AIR.STATION)-LAT(CASE))*57.29577)*60.
    LET DIST.TO.CASE = KNOTS.UP + (DOS(CASE)*.88)
    GO TO 77
ELSE
IF LAT(CASE) GE CUTOFF AND AS.LAT(AIR.STATION) LT CUTOFF
    LET UP.MILES=(CUTOFF-AS.LAT(AIR.STATION))*57.29577*60.
    LET KNOTS.UP=((LAT(CASE)-CUTOFF)*57.29577*60.)*((2.)**.5)
    LET OUT.KTS=2.*DOS(CASE)*.88
    LET DIST.TO.CASE=KNOTS.UP + OUT.KTS + UP.MILES
    GO TO 77
ELSE
IF LAT(CASE) LT CUTOFF AND AS.LAT(AIR.STATION) GE CUTOFF
```

```
        LET UP.MILES=((2.)**.5)*((AS.LAT(AIR.STATION)-CUTOFF)*
                            57.29577*60.)
        LET KNOTS.UP=(CUTOFF-LAT(CASE))*57.29577*60.
        LET OUT.KTS= DOS(CASE)*.88
        LET DIST.TO.CASE=KNOTS.UP + OUT.KTS + UP.MILES
        GO TO 77
    ELSE
    IF LAT(CASE) GE CUTOFF AND AS.LAT(AIR.STATION) GE CUTOFF
        LET KNOTS.UP=(ABS.F(DIST.FM.AS**2.-(.88*DOS(CASE))**2.))**.5
        LET DIST.TO.CASE = KNOTS.UP + DOS(CASE)
    ALWAYS
'77' RETURN WITH DIST.TO.CASE
    LOOP
    END ''OF DISTANCE TO CASE ROUTINE



    MAIN


    READ N.AIR.STATION,MR.FLAG, HH.FLAG
    READ SEED
    CREATE EVERY AIR.STATION
    FOR EVERY AIR.STATION, DO THE FOLLOWING
        READ NAME(AIR.STATION), AS.LAT(AIR.STATION),
            AS.LONG(AIR.STATION), NUM.HH(AIR.STATION),
            NUM.MRR(AIR.STATION), LNG.MULT(AIR.STATION)
        IF NUM.HH(AIR.STATION) GT 0 AND NUM.MRR(AIR.STATION) EQ 0
            LET AC.ATT.STATUS(AIR.STATION) = 0
        ALWAYS
        IF NUM.HH(AIR.STATION) EQ 0 AND NUM.MRR(AIR.STATION) GT 0
            LET AC.ATT.STATUS(AIR.STATION) = 1
        ALWAYS
        IF NUM.HH(AIR.STATION) GT 0 AND NUM.MRR(AIR.STATION) GT 0
            LET AC.ATT.STATUS(AIR.STATION) = 2
        ALWAYS
        LET CASE.COUNT(AIR.STATION) = 0
        LET NO.HH.LAUNCH(AIR.STATION) = 0
        LET NO.MR.LAUNCH(AIR.STATION) = 0
        LET STATUS(AIR.STATION) = 1
    LOOP
    LET HH.SPEED = 90.0
    LET HH.RANGE = 150.0
    LET HH.ENDUR = 3.6666
    LET MRR.SPEED = 140.0
    LET MRR.RANGE = 165.0
    LET MRR.ENDUR = 4.05
    PRINT 8 LINES WITH N.AIR.STATION THUS
```

```
                A SIMULATION OF THE CCGD7 AIR SAR TRAFFIC
                    TO INVESTIGATE OPTIMUM LOCATION
                  SCHEMES WITH RESPECT TO AIR STATION
                              LOCATIONS.

** AIR STATIONS WERE USED FOR THIS RUN.
LOCATIONS AND LOGISTICS ARE AS FOLLOWS:

FOR EVERY AIR.STATION, DO THE FOLLOWING
    PRINT 8 LINES WITH NAME(AIR.STATION),
    AS.LAT(AIR.STATION)*57.29577, AS.LONG(AIR.STATION)*57.29577,
    NUM.HH(AIR.STATION), NUM.MRR(AIR.STATION)  THUS


AIR STATION ************
LATITUDE:  **.**** N
LONGITUDE:  **.**** W
** HH52A AND ** MRRAC AIRCRAFT ARE ATTACHED.


LOOP
SCHEDULE A STOP.SIM AT 365.0
LET X.NUM = 0
START SIMULATION
END


EVENT ENIGMA  '' A SEARCH CASE......


ADD 1 TO X.NUM
READ SSEAS(ENIGMA),SWINDS(ENIGMA),SVIS(ENIGMA),SSEV(ENIGMA),
    SR.LNG(ENIGMA), SR.LAT(ENIGMA),SDOS(ENIGMA),STSEM(ENIGMA),
   SNOM1(ENIGMA),SSER.1(ENIGMA),SNOM2(ENIGMA),SSER.2(ENIGMA),
   SNOM3(ENIGMA),SSER.3(ENIGMA)
CREATE A CASE
LET CASE.NUM(CASE) = X.NUM
LET SEAS(CASE) =SSEAS(ENIGMA)
LET WINDS(CASE) =SWINDS(ENIGMA)
LET VIS(CASE) =SVIS(ENIGMA)
LET SEV(CASE) =SSEV(ENIGMA)
LET LONG(CASE) = SR.LNG(ENIGMA)
LET LAT(CASE) = SR.LAT(ENIGMA)
LET DOS(CASE) =SDOS(ENIGMA)
LET TSEM(CASE) =STSEM(ENIGMA)
LET NOM1(CASE) =SNOM1(ENIGMA)
LET SER.1(CASE) =SSER.1(ENIGMA)
```

```
        LET NCM2(CASE) =SNCM2(ENIGMA)
        LET SER.2(CASE) =SSER.2(ENIGMA)
        LET NCM3(CASE) =SNCM3(ENIGMA)
        LET SER.3(CASE) =SSER.3(ENIGMA)
        LET TYPE(CASE) = 0
''
''
''THE EVENT ATTRIBUTES ARE STORED IN THE TEMPORARY ENTITY CASE SO THAT
''THEY CAN BE TRANSFERRED TO THE EVENT LAUNCH, IF NEEDED.
''
'' NOW CHECK FOR MAXIMUM RANGE VIOLATIONS.
''
        IF SDOS(ENIGMA) GT MRR.RANGE        AND MR.FLAG EQ 1, GO TO 98
        ELSE
        IF MR.FLAG EQ 1 AND HH.FLAG EQ 1
            IF DCS(CASE) GE 25
                GO TO 1
            ELSE
                LET AC.TYPE(CASE) = 2
                SCHEDULE A LAUNCH GIVEN CASE NOW
                PRINT 2 LINES WITH X.NUM THUS

A LAUNCH FOR CASE ****, A NONSEARCH CASE, WILL BE SCHEDULED NOW.
                GO TO 99
        ELSE
''
''
        IF SDOS(ENIGMA) GT 25.0 AND MR.FLAG EQ 0
            PRINT 4 LINES WITH X.NUM,SDOS(ENIGMA) THUS

            THIS IS A SEARCH CASE, CASE NUMBER ****, LOCATED ****.** MILES OFF
            THE COAST. MERAC ARE NOT AVAILABLE SO A C-130 FROM AIR STATION
            CLEARWATER WILL BE CALLED.
            ADD 1 TO C130.CALLS
            LET KNTS.UP = ((0.4872378 - SR.LAT(ENIGMA))*57.29577)*60.0)
            LET OUT.KNTS = ((1.4430966 - SR.LNG(ENIGMA))*57.29577)*52.0)
            LET KNTS.UP = ABS.F(KNTS.UP)
            LET OUT.KNTS = ABS.F(OUT.KNTS)
            LET MILEAGE = (KNTS.UP**2. + OUT.KNTS**2.)**.5
            LET HRS.OUT = MILEAGE/300.0
            LET RESPONCE.TIME = HRS.OUT
            LET SRCH.HRS =  TSEM(ENIGMA)/150.0
            LET TOT.HRS = HRS.OUT + SRCH.HRS
            LET SER.2(CASE) = 0.0
            LET SER.3(CASE) = 0.0
            LET TSEM(CASE) = 0.0
''
'' CHECK TO SEE IF AN HH52A WILL BE NEEDED WHEN THE OBJECTS ARE FOUND.
```

```
''
          IF SNCM1(ENIGMA) EQ "RESC"
             IF SDOS(ENIGMA) GT HH.RANGE      , GO TO 97
             ELSE
             LET AC.TYPE(CASE) = 130
             SCHEDULE A LAUNCH GIVEN CASE IN TOT.HRS HOURS
             GO TO  99
          ELSE
             PRINT 2 LINES WITH X.NUM  THUS

             CASE **** WILL BE SERVICED COMPLETELY BY A C-130.
          DESTROY CASE
          GO TO 99
       ELSE
  '1' IF MR.FLAG EQ 1 '' THE CASE WILL BE SERVICED BY A MRRAC, IF AVAILABLE
          PRINT 3 LINES WITH X.NUM AND SDOS(ENIGMA) THUS

    CASE ***, LOCATED ***.** MILES OFFSHORE IS A SEARCH CASE AND MRRAC
    WILL BE UTILIZED, IF AVAILABLE. THE LAUNCH IS NOW BEING SCHEDULED.
          LET AC.TYPE(CASE) = 1
          SCHEDULE A LAUNCH GIVEN CASE NOW
          GO TO 99
       ELSE
       IF SDOS(ENIGMA) LT 25.0 AND MR.FLAG EQ 0
          LET AC.TYPE(CASE) = C
          SCHEDULE A LAUNCH GIVEN CASE NOW
          PRINT 2 LINES WITH X.NUM THUS

   A LAUNCH FOR CASE ****, A SEARCH CASE, WILL BE SCHEDULED IMMEDIATELY.
          GO TO 99
       ELSE
       PRINT 1 LINE WITH X.NUM THUS
$$$$$$$$$$$$ YOU FOOL, A MISTAKE HAS BEEN MADE WITH SEARCH CASE ***. $$$$$$$$$$$
       GO TO 99
''
''
 '97' PRINT 3 LINES WITH X.NUM AND SDOS(ENIGMA) THUS

       CASE *** IS LOCATED ***.** MILES OFF THE COAST, OUT OF THE RANGE
       OF AN HH52A. THE EVACUATION WILL HAVE TO EFFECTED BY A SHIP.
       GO TO 99
''
''
 '98' PRINT 3 LINES WITH X.NUM AND SDOS(ENIGMA) THUS

    CASE *** IS LOCATED ***.** MILES OFFSHORE, OUT OF THE EFFECTIVE
    RANGE OF A MRRAC SO A C-130 HAS TO BE USED.
          LET KNTS.UP = ((0.4872378 - SR.LAT(ENIGMA))*57.29577)*60.0
```

```
        LET CLT.KNTS = ((1.4430966 - SR.LNG(ENIGMA))*57.29577)*52.0
        LET KNTS.UP = ABS.F(KNTS.UP)
        LET CLT.KNTS = ABS.F(OUT.KNTS)
        LET MILEAGE = (KNTS.UP**2. + OUT.KNTS**2.)**.5
        LET HRS.OUT = MILEAGE/300.0
        LET RESPONSE.TIME = HRS.OUT
        DESTROY CASE
'99' END


     EVENT NOSRCH  '' A NONSEARCH CASE .....


     ADD 1 TO X.NUM
     READ NSEAS(NOSRCH), NWINDS(NOSRCH), NVIS(NOSRCH), NSEV(NOSRCH),
          NLONG(NOSRCH), NLAT(NOSRCH), NDOS(NOSRCH),
          NNOM1(NOSRCH), NSER.1(NOSRCH), NNOM2(NOSRCH), NSER.2(NOSRCH),
          NNOM3(NOSRCH), NSER.3(NOSRCH)
     CREATE A CASE
     LET CASE.NUM(CASE) = X.NUM
     LET SEAS(CASE) =NSEAS(NOSRCH)
     LET WINDS(CASE) =NWINDS(NOSRCH)
     LET VIS(CASE) =NVIS(NOSRCH)
     LET SEV(CASE) =NSEV(NOSRCH)
     LET LONG(CASE) = NLONG(NOSRCH)
     LET LAT(CASE) = NLAT(NOSRCH)
     LET DOS(CASE) =NDOS(NOSRCH)
     LET NOM1(CASE) =NNOM1(NOSRCH)
     LET SER.1(CASE) =NSER.1(NOSRCH)
     LET NOM2(CASE) =NNOM2(NOSRCH)
     LET SER.2(CASE) =NSER.2(NOSRCH)
     LET NOM3(CASE) =NNOM3(NOSRCH)
     LET SER.3(CASE) =NSER.3(NOSRCH)
     LET TYPE(CASE) = 1
''
'' THE EVENT ATTRIBUTES HAVE BEEN READ INTO CASE, A TEMPORARY ENITY CREATED TO
'' TRANSFER THESE ATTRIBUTES TO THE LAUNCH, IF NEEDED.
''
'' NOW CHECK FOR MAXIMUM RANGE VIOLATIONS.
''
     IF NDOS(NOSRCH) GT ARR.RANGE        AND MR.FLAG EQ 1, GO TO 98
     ELSE
''
     IF MR.FLAG EQ 1 AND HH.FLAG EQ 1
          IF DOS(CASE) GE 25
             GO TO 1
          ELSE
```

```
            LET AC.TYPE(CASE) = 2
            SCHEDULE A LAUNCH GIVEN CASE NOW
            PRINT 2 LINES WITH X.NUM THUS

A LAUNCH FOR CASE ****, A NONSEARCH CASE, WILL BE SCHEDULED NOW.
            GC TO 99
      ELSE
      IF NDOS(NCSRCH) GT 25.0 AND MR.FLAG EQ 0
          PRINT 4 LINES WITH X.NUM,NDOS(NOSRCH) THUS

          THIS IS A NONSEARCH CASE, CASE NUMBER ****, LOCATED ****.** MILES
          OFFSHORE. MRRAC ARE NOT AVAILABLE SO A C-130 FROM AIR ATATION
          CLEARWATER WILL BE CALLED.
            ADD 1 TO C130.CALLS
            LET KNTS.UP=((0.4872378-NLAT(NOSRCH))*57.29577)*60.0
            LET OUT.KNTS=((1.4430966-NLONG(NCSRCH))*57.29577)*52.0
            LET KNTS.UP = ABS.F(KNTS.UP)
            LET OUT.KNTS = ABS.F(OUT.KNTS)
            LET MILEAGE = (KNTS.UP**2. + OUT.KNTS**2.)**.5
            LET HRS.OUT = MILEAGE/300.)
            LET SER.2(CASE) = 0.0
            LET SER.3(CASE) = 0.0
             LET RESPONCE.TIME = HRS.OUT
''
'' CHECK TO SEE IF AN HH52A WILL BE NEEDED WHEN THE C-130 IS CNSCENE.
''
            IF NNOM1(NOSRCH) EQ "RESC"
          '' AN HH52A WILL BE NEEDED WHEN THE C-130 IS CNSCENE.
                IF NDOS(NCSRCH) GT HH.RANGE     , GO TO 97
                ELSE
                LET AC.TYPE(CASE) = 130
                SCHEDULE A LAUNCH GIVEN CASE IN HRS.OUT HOURS
                GO TO 99
            ELSE
            PRINT 2 LINES WITH X.NUM  THUS

            CASE **** WILL BE SERVICED COMPLETELY BY A C-130.
            DESTROY CASE
            GC TO 99
      ELSE
  '1' IF MR.FLAG EQ 1 '' THE CASE WILL BE SERVICED BY A MRRAC, IF AVAILABLE
          PRINT 3 LINES WITH X.NUM AND NDOS(NOSRCH) THUS

        CASE ***, LOCATED ***.** MILES OFFSHORE IS A NONSEARCH CASE AND
        MRRAC WILL BE UTILIZED, IF AVAILABLE. LAUNCH NOW BEING SCHEDULED.
          LET AC.TYPE(CASE) = 1
          SCHEDULE A LAUNCH GIVEN CASE NOW
          GO TO 99
```

```
        ELSE
''
        IF NDOS(NDSRCH) LT 25.0 AND MR.FLAG EQ 0
             LET AC.TYPE(CASE) = 0
             SCHEDULE A LAUNCH GIVEN CASE NOW
             PRINT 2 LINES WITH X.NUM THUS
    A LAUNCH FOR CASE ****, A NON SEARCH CASE, WILL BE SCHEDULED IMMEDIATELY.
             GO TO 99
        ELSE
''
        PRINT 1 LINE WITH X.NUM THUS
$$$$$$$$$ YOU FOOL, A MISTAKE HAS BEEN MADE WITH A NONSEARCH CASE ***. $$$$$$$$$
        GO TO 99
''
''
 '97' PRINT 3 LINES WITH X.NUM AND NDOS(NDSRCH) THUS
        CASE *** IS LOCATED ***.** MILES OFF THE COAST, OUT OF THE RANGE
        OF AN HH52A. THE EVACUATION WILL HAVE TO EFFECTED BY A SHIP.
        DESTROY CASE
        GO TO 99
''
''
 '98' PRINT 3 LINES WITH X.NUM AND NDOS(NDSRCH) THUS
      CASE *** IS LOCATED ***.** MILES OFFSHORE, OUT OF THE EFFECTIVE
      RANGE OF A MRRAC SO A C-130 HAS TO BE USED.
             LET KNTS.UP = ((0.4872378 - SR.LAT(ENIGMA))*57.29577)*60.0
             LET OUT.KNTS = ((1.4430966 - SR.LNG(ENIGMA))*57.29577)*52.0
             LET KNTS.UP = ABS.F(KNTS.UP)
             LET OUT.KNTS = ABS.F(OUT.KNTS)
             LET MILEAGE = (KNTS.UP**2. + OUT.KNTS**2.)**.5
             LET HRS.OUT = MILEAGE/300.0
             LET RESPONCE.TIME = HRS.OUT
             DESTROY CASE
 '99' END

        EVENT LAUCH GIVEN THIS.CASE

        DEFINE THIS.CASE AS AN INTEGER VARIABLE
        LET CASE = THIS.CASE
''
''
'' AT THIS POINT THE SYSTEM NOW HAS TO LAUNCH A HELO, EITHER TO SERVICE THE
```

```
'' CASE COMPLETELY OR TO ASSIST A C-130 ON THE CASE.
''
'' COMPUTE THE CLOSEST AVAILABLE AIR STATION.
''
      LET STAR = N.AIR.STATION
      LET CLOSEST.AS = "NONE"
  '2' LET DIST.FM.AS = 10000.0
      FOR EVERY AIR.STATION, DO THE FOLLOWING
          IF STAR = 0, GO TO 98
          ELSE '' THERE ARE STATIONS AVAILABLE
          IF NAME(AIR.STATION) EQ CLOSEST.AS OR STATUS(AIR.STATION)
                                        = 0, GO TO 1
          ELSE
          LET KNOTS.UP = ((AS.LAT(AIR.STATION)-LAT(CASE))*57.29577)*60.
          LET OUT.KTS = ((AS.LONG(AIR.STATION)-LONG(CASE))*57.29577)*
                        LNG.MULT(AIR.STATION)
          LET KNOTS.UP = ABS.F(KNOTS.UP)
          LET OUT.KTS = ABS.F(OUT.KTS)
          LET MILEAGE = ((KNOTS.UP)**2. + (OUT.KTS)**2.)**.5
          IF MILEAGE LE DIST.FM.AS
              LET DIST.FM.AS =  MILEAGE
              LET CLOSEST.AS =  NAME(AIR.STATION)
          ALWAYS
  '1' LOOP
''
'' NOW WE HAVE THE CLOSEST AVAILABLE AIR STATION TO THIS CASE.
'' PRINT OUT THIS DATA.
''
      PRINT 5 LINES WITH CASE.NUM(CASE), LAT(CASE)*57.3,
          LONG(CASE)*57.3, CLOSEST.AS, DIST.FM.AS  THUS

          CASE NUMBER ****, AT **.**N AND **.**W REQUIRES A LAUNCH NOW.
          AIR STATION ********** IS ****.** KNOTS AWAY AND
          WILL BE CALLED UPON TO LAUNCH.
''
'' DETERMINE IF THIS AIR STATION WILL BE ABLE TO RESPOND WITH AN AIR
'' RESOURCE. THE PROBABILITIES ASSOCIATED WITH THE NUMBER OF AIRCRAFT
'' PRESENTLY ON BASE WERE EXTRACTED FROM THE AVIATION PLAN, FY 1981-1990, AND
'' USED WITH THE SIMSCRIPT II.5 UNIFORM RANDOM NUMBER GENERATOR.
''
'' CHECK TO SEE WHAT TYPE OF AIRCRAFT IS GOING TO BE USED.
''
      IF AC.TYPE(CASE) EQ 1, GO TO 9
      ELSE
 '19' FOR EACH AIR.STATION WITH NAME(AIR.STATION) EQ CLOSEST.AS, DO
          IF NUM.HH(AIR.STATION) EQ 0, GO TO 13
          ELSE
```

```
        LET PROB.AC.OR = UNIFORM.F(0.0,1.0,SEED)
        IF NUM.HH(AIR.STATION) EQ 1 AND PROB.AC.OR GT 0.8
            GO TO 4
        ELSE
        IF NUM.HH(AIR.STATION) EQ 2 AND PROB.AC.OR GT 0.9709
            GO TO 4
        ELSE
        IF NUM.HH(AIR.STATION) EQ 3 AND PROB.AC.OR GT 0.9962
            GO TO 4
        ELSE
        GO TO 5
    LOOP
'4' PRINT 4 LINES WITH CLOSEST.AS  THUS

        THE CLOSEST AIR STATION, ****, WAS UNABLE TO LAUNCH AN HH52A.
        THE NEXT CLOSEST AIR STATION WITH HH52AS WILL BE NOTIFIED.

'12' FOR EACH AIR.STATION WITH NAME(AIR.STATION) EQ CLOSEST.AS, DO
        LET STATUS(AIR.STATION) = 0
        SUBTRACT 1 FROM STAR
        IF AC.TYPE(CASE) EQ 0
            ADD 1 TO NO.HH.LAUNCH(AIR.STATION)
        OTHERWISE
            ADD 1 TO NO.MR.LAUNCH(AIR.STATION)
        ALWAYS
        GO TO 2
    LOOP
'13' IF AC.TYPE(CASE) EQ 2
        PRINT 2 LINES WITH CLOSEST.AS AND CASE.NUM(CASE) THUS
**  THERE WERE NO HH52A'S AVAILABLE FOR LAUNCH SO THE MRRAC ATTACHED
   WILL BE LAUNCHED FROM AIRSTA **** FOR CASE ***
        LET AC.TYPE(CASE) = 1
        GO TO 9
    ELSE
    PRINT 5 LINES WITH CLOSEST.AS, CASE.NUM(CASE) THUS
     THE CLOSEST AIR STATION, ****, HAS NO HH52AS TO LAUNCH.
     THIS CASE, ***, WILL BE QUEUED IF IT HAS A SEVERITY
     CODE OF 0 AND THE STATION HAS HH52AS ATTACHED. THE NEXT
     CLOSEST AIR STATION WILL BE NOTIFIED IF THE SEVERITY IS 1 OR
     IF NO HH52AS ARE ATTACHED.
''
    FOR EACH AIR.STATION WITH NAME(AIR.STATION) EQ CLOSEST.AS, DO
        IF SEV(CASE) EQ 1 OR AC.ATT.STATUS(AIR.STATION) EQ 1
            GO TO 12
        ELSE
            LET TIME.IN.QUEUE(CASE) = TIME.V
            FILE CASE IN AS.QUEUE(AIR.STATION)
    LOOP
```

```
        GO TO 99
   '9'  FOR EACH AIR.STATION WITH NAME(AIR.STATION) EQ CLOSEST.AS, DO
            IF NUM.MRR(AIR.STATION) EQ 0, GO TO 14
            ELSE
            LET PROB.AC.OR = UNIFORM.F(0.0,1.0,SEED)
            IF NUM.MRR(AIR.STATION) EQ 1 AND PROB.AC.OR GT 0.85
               GO TO 15
            ELSE
            IF NUM.MRR(AIR.STATION) EQ 2 AND PROB.AC.OR GT 0.98
               GO TO 15
            ELSE
            IF NUM.MRR(AIR.STATION) EQ 3 AND PROB.AC.OR GT 0.998
               GO TO 15
            ELSE
            GO TO 5
     LOOP
  '14' PRINT 5 LINES WITH CLOSEST.AS, CASE.NUM(CASE) THUS

    THE CLOSEST AIR STATION, ****, HAS NO MRRAC TO LAUNCH. CASE
    *** WILL BE QUEUED IF IT HAS A SEVERUTY CODE OF 0 AND
    THE STATION HAS MRRAC ATTACHED. IF THE SEVERITY CODE IS 1 OR IF
    NO MRRAC ARE ATTACHED THEN THE NEXT CLOSEST AIR STATION WILL BE CALLED.
''
        FOR EACH AIR.STATION WITH NAME(AIR.STATION) EQ CLOSEST.AS, DO
            IF SEV(CASE) EQ 1 OR AC.ATT.STATUS(AIR.STATION) EQ 0
               GO TO 12
            ELSE
               LET TIME.IN.QUEUE(CASE) = TIME.V
               FILE CASE IN AS.QUEUE(AIR.STATION)
        LOOP
        GO TO 99
  '15' PRINT 3 LINES WITH CLOSEST.AS THUS

        THE CLOSEST AIR STATION, ****, WAS UNABLE TO LAUNCH A MRRAC.
      THE NEXT CLOSEST AIR STATION WITH MRRAC WILL BE NOTIFIED.
''
''
        GO TO 12
''
'' AT THIS POINT AN AIRCRAFT OF SOME SORT IS AVAILABLE FOR TAKEOFF.
''
   '5'  IF AC.TYPE(CASE) EQ 1, GO TO 16 '' FOR MRRAC CALCULATIONS
        ELSE
        IF AC.TYPE(CASE) = 130, GO TO 8
        ELSE
        IF TYPE(CASE) = 0, GO TO 6 '' FOR SEARCHING CALCULATIONS.
        ELSE '' WE HAVE A NONSEARCH CASE.
```

```
IF DOS(CASE) LT 25.0 AND DIST.FM.AS GT 22.0
    IF NOM1(CASE) NE "ABRT"
        LET TIME = SER.1(CASE)+SER.2(CASE)+SER.3(CASE)
        LET REFUEL = TRUNC.F((DISTANCE.TO.CASE + DOS(CASE))/300.)
           LET RESPONCE.TIME = DISTANCE.TO.CASE/HH.SPEED + REFUEL
    SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND AC.TYPE(CASE)
        IN ((RESPONCE.TIME*2.0)+TIME) HOURS
    GO TO 7
    ELSE
    PRINT 3 LINES WITH CASE.NUM(CASE)  THUS

    CASE **** WAS ABORTED.

    ADD 1 TO ABORTED.CASES
    SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND AC.TYPE(CASE)
         IN SER.1(CASE) HOURS
    GO TO 7
ELSE
IF DIST.FM.AS LE 22.0
    LET TIME = SER.1(CASE)+SER.2(CASE)+SER.3(CASE)
    LET RESPONCE.TIME = DIST.FM.AS/HH.SPEED
    SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND AC.TYPE(CASE)
         IN ((RESPONCE.TIME*2.0)+TIME) HOURS
    GO TO 7
ELSE
''
''
'' TO ARRIVE AT THIS POINT THE DOS MUST BE GT 25 MILES AND THE SERVICES
'' OF AN HH52A ARE NEEDED, I.E. RES.EV.
''
''
 '8' LET TIME = SER.1(CASE)
     IF DIST.FM.AS GT HH.RANGE
        PRINT 1 LINE THUS
?????? THE HELO MUST GO UP AND OVER.    ?????
        LET REFUEL = TRUNC.F((DISTANCE.TO.CASE + DOS(CASE))/300.)
        LET TRANSIT.TIME = DISTANCE.TO.CASE/HH.SPEED + REFUEL
     OTHERWISE
        LET REFUEL = 0
        LET TRANSIT.TIME = DIST.FM.AS/HH.SPEED
     ALWAYS
     SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND AC.TYPE(CASE) IN
        ((TRANSIT.TIME*2.) + TIME) HOURS
     GO TO 7
''
'' WE HAVE A SEARCH CASE.
''
 '6' IF DOS(CASE) LT 25.0 AND DIST.FM.AS GT 22.0
```

```
            IF NCM1(CASE) NE "ABRT"
                LET TIME = SER.1(CASE)+SER.2(CASE)+SER.3(CASE)
            LET REFUEL = TRUNC.F((DISTANCE.TO.CASE + DOS(CASE))/300.)
            LET RESPONCE.TIME=DISTANCE.TO.CASE/HH.SPEED + REFUEL
                SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND
                    AC.TYPE(CASE) IN
                    ((RESPONCE.TIME*2.)+TIME+(TSEM(CASE)/(HH.SPEED*4.)))
                    HOURS
                GO TO 7
            ELSE
                PRINT 3 LINES WITH CASE.NUM(CASE)  THUS

                CASE **** WAS ABORTED.

                ADD 1 TO ABORTED.CASES
                SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND
                    AC.TYPE(CASE) IN SER.1(CASE) HOURS
                GO TO 7
        ELSE
        IF DIST.FM.AS LE 22.0
            LET TIME = SER.1(CASE)+SER.2(CASE)+SER.3(CASE)
            LET RESPONCE.TIME = ((DIST.FM.AS)/HH.SPEED)
            SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND AC.TYPE(CASE)
                IN (RESPONCE.TIME*2. + (TSEM(CASE)/(HH.SPEED*4.))+TIME)
                HOURS
            GO TO 7
        ELSE  '' DOS IS GREATER THAN 25 MILES AND A HELO WILL BE NEEDED,
              '' THE SEARCH WAS PERFORMED BY A C-130.
            GO TO 8
''
'' SET ALL AIR STATION STATUS VALUES BACK TO 1.
''
 '7' FOR EVERY AIR.STATION, DO
            LET STATUS(AIR.STATION) = 1
        LOOP
        FOR EVERY AIR.STATION WITH NAME(AIR.STATION) EQ CLOSEST.AS, DO
            SUBTRACT 1 FROM NUM.HH(AIR.STATION)
            ADD 1 TO CASE.COUNT(AIR.STATION)
        LOOP
        GO TO 99
''
'' BEGIN MRRAC CALCULATIONS.
''
'16' IF NCM1(CASE) NE "ABRT"
            LET TIME = SER.1(CASE) + SER.2(CASE) + SER.3(CASE)
        IF DIST.FM.AS GT MRR.RANGE
                PRINT 1 LINE THUS
$$$$$ THE MRRAC MUST GO UP AND OUT.   $$$$$
```

```
          LET DIST.FM.AS = DISTANCE.TO.CASE
       IF DIST.FM.AS + 2*DCS(CASE)  GE  MFR.RANGE
          LET REFUEL=TRUNC.F((DIST.FM.AS + 2.*DCS(CASE))/400.)
          ELSE
             LET REFUEL = 0
          ALWAYS
          LET RESPONCE.TIME = DIST.FM.AS/MRR.SPEED + REFUEL
       OTHERWISE
          LET RESPONCE.TIME = DIST.FM.AS/MRR.SPEED
       ALWAYS
       IF TYPE(CASE) = 0
          LET TIME = TIME + TSEM(CASE)/(MRR.SPEED*4.)
       ALWAYS
       SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND AC.TYPE(CASE)
          IN ((RESPONCE.TIME*2.0) + TIME) HOURS
       GO TO 18
    ELSE
       PRINT 2 LINES WITH CASE.NUM(CASE) THUS

CASE *** WAS ABORTED.
       ADD 1 TO ABORTED.CASES
       SCHEDULE A RETURN.TO.BASE GIVEN CLOSEST.AS AND AC.TYPE(CASE)
          IN SER.1(CASE) HOURS
 '18' FOR EVERY AIR.STATION, DO
       LET STATUS(AIR.STATION) = 1
    LOOP
    FOR EVERY AIR.STATION WITH NAME(AIR.STATION) EQ CLOSEST.AS, DO
       SUBTRACT 1 FROM NUM.MRR(AIR.STATION)
       ADD 1 TO CASE.COUNT(AIR.STATION)
    LOOP
    GO TO 99
 '98' IF AC.TYPE(CASE) EQ 1, GO TO 97
    ELSE
    PRINT 4 LINES WITH CASE.NUM(CASE)  THUS

       NO AIR STATION IN THE SYSTEM WAS ABLE TO
       RESPOND TO CASE NUMBER ****, WITH AN HH52A.

    ADD 1 TO NO.RESPONCE.CASES
 '20' FOR EVERY AIR.STATION, DO THE FOLLOWING
       LET STATUS(AIR.STATION) = 1
    LOOP
    DESTROY CASE
    GO TO 99
''
''
'' HERE WE HAVE A BIG PROBLEM. MRRAC WERE TO BE USED, HOWEVER THERE WERE
'' NONE AVAILABLE FOR USE SO WE HAVE TO LOOK FOR AN HH52A (IF THEY ARE IN
```

```
'' USED) OR CALL FOR A C-130 TO SERVICE THIS CASE.
''
''
'97' PRINT 3 LINES WITH CASE.NUM(CASE) THUS

NO AIR STATION IN THE SYSTEM WAS ABLE TO RESPOND TO
CASE NUMBER ***, WITH A MRRAC.
''
'' IF HH52AS ARE IN SERVICE CHANGE THE AC.TYPE VALUE, RESET
'' AIR STATIONS STATUS VALUES AND REWORK THE CASE.
''
      IF DOS(CASE) LE 25.0 AND HH.FLAG EQ 1
            PRINT 2 LINES WITH CASE.NUM(CASE) AND DOS(CASE) THUS

CASE ***, ***.** MILES OFFSHORE NOW NEEDS AN HH52A, IF AVAILABLE.
            LET STAR = N.AIR.STATION
            LET CLOSEST.AS = "NONE"
            LET AC.TYPE(CASE) = 0
            FOR EVERY AIR.STATION, DO THE FOLLOWING
                  LET STATUS(AIR.STATION) = 1
            LOOP
            GO TO 2
      ELSE
            LET OUT.KTS=ABS.F(((1.4430966-LONG(CASE))*57.29577)*52.0)
            LET KNOTS.UP=ABS.F(((0.4872378-LAT(CASE))*57.29577)*60.0)
            LET MILEAGE = (KNOTS.UP**2. + OUT.KTS**2.)**.5
      IF HH.FLAG EQ 0
            PRINT 2 LINES WITH CASE.NUM(CASE) THUS

HH52AS ARE NOT IN USE SO A C-130 MUST BE CALLED FOR CASE ***.
            LET RESPONCE.TIME = MILEAGE/300.0
            ADD 1 TO C130.CALLS
            GO TO 20
      OTHERWISE '' HH52AS ARE IN USE BUT THE CASE IS TO FAR OFF THE COAST
            PRINT 2 LINES WITH CASE.NUM(CASE) AND DOS(CASE) THUS

CASE ***, LOCATED ***.** MILES OFFSHORE NOW NEEDS A C-130
            LET RESPONCE.TIME = MILEAGE/300.0
            ADD 1 TO C130.CALLS
            IF NOM1(CASE) EQ "RESC"
                  PRINT 1 LINE THUS
AND IT WILL ALSO REQUIRE AN HH52A LATER.
                  IF TYPE(CASE) EQ 0
                        LET SRCH.TIME = TSCM(CASE)/(150.*4.)
                        LET TIME = RESPONCE.TIME + SRCH.TIME
                  OTHERWISE
                        LET TIME = RESPONCE.TIME
                  ALWAYS
```

```
            LET AC.TYPE(CASE) = 130
            SCHEDULE A LAUNCH GIVEN CASE IN TIME HOURS
        OTHERWISE
            PRINT 1 LINE THUS
  TO BE SERVICED COMPLETELY.
            GO TO 20
        ALWAYS
    FOR EVERY AIR.STATION, DO THE FOLLOWING
        LET STATUS(AIR.STATION) = 1
    LOOP
'99' END


    EVENT RETURN.TO.BASE GIVEN STATION AND CRAFT


    DEFINE STATION AS AN ALPHA VARIABLE
    DEFINE CRAFT AS AN INTEGER VARIABLE
    FOR EVERY AIR.STATION WITH NAME(AIR.STATION) EQ
        STATION, DO THE FOLLOWING
        IF CRAFT EQ 1
            ADD 1 TO NUM.MRR(AIR.STATION)
        OTHERWISE
            ADD 1 TO NUM.HH(AIR.STATION)
        ALWAYS
        IF AS.QUEUE(AIR.STATION) IS NOT EMPTY,
            REMOVE THE FIRST CASE FROM AS.QUEUE(AIR.STATION)
            LET WAIT.TIME(AIR.STATION) = TIME.V - TIME.IN.QUEUE(CASE)
            SCHEDULE A LAUNCH GIVEN CASE IN 1.0 HOURS
        ALWAYS
    LOOP
    END


    EVENT STOP.SIM


    DEFINE I AS AN INTEGER VARIABLE
    FOR EVERY AIR.STATION, DO THE FOLLOWING
        PRINT 10 LINES WITH NAME(AIR.STATION), CASE.COUNT(AIR.STATION),
            NO.HH.LAUNCH(AIR.STATION), NO.MR.LAUNCH(AIR.STATION),
            HH.GRAPH(AIR.STATION,1), HH.GRAPH(AIR.STATION,2),
            HH.GRAPH(AIR.STATION,3), HH.GRAPH(AIR.STATION,4),
            MR.GRAPH(AIR.STATION,1), MR.GRAPH(AIR.STATION,2),
            MR.GRAPH(AIR.STATION,3), MR.GRAPH(AIR.STATION,4),
            NUM.WHO.WAITED, AVG.WAIT.TIME*1440. AND SD.WAIT.TIME*1440.
```

```
              THUS
FOR AIR STATION **** THE FOLLOWING DATA WAS OBTAINED:
               *** CASES WERE ANSWERED.
               ** TIMES AN HH52A WAS UNABLE TO LAUNCH.
               ** TIMES A MRRAC WAS UNABLE TO LAUNCH.
               ***.**,***.**,***.**,***.** ARE THE HISTOGRAM VALUES FOR THE HH52
               ***.**,***.**,***.**,***.** ARE THE HISTOGRAM VALUES FOR THE MRAC
         *** CASES WERE QUEUED WITH A MEAN WAITING TIME IN THE
         QUEUE OF ***.** MINUTES. (STD.DEV. OF WAIT TIME = ******.**)


      LOOP
''
''
      PRINT 9 LINES WITH AVG.RESP.TIME*60.,
          SD.RESP.TIME*60., X.NUM, ANSWERED.CASES, ABORTED.CASES,
          C130.CALLS AND NO.RESPONCE.CASES THUS
FOR THIS RUN: THE AVERAGE RESPONCE TIME WAS ****.** MINUTES,
              WITH A STANDARD DEVIATION OF *****.** MINUTES,
              FOR A CASELOAD OF **** CASES.
              *** CASES WERE RESPONDED TO BY THE SYSTEM.
              ** CASES WERE ABORTED DURING THIS RUN.
              A C-130 WAS CALLED FOR *** TIMES.
              THERE WERE ** CASES WHERE THE SYSTEM WAS UNABLE TO RESPOND.


      FOR I=1 TO 41, DO THE FOLLOWING
          IF I EQ 41
              PRINT 1 LINE WITH RT.GRAPH(I) THUS
              *** CASES HAD A RESPONCE TIME GREATER THAN 120 MINUTES.
              GO TO 1
          ELSE
          PRINT 1 LINE WITH RT.GRAPH(I) AND 3*I THUS
              *** CASES HAD A RESPONCE TIME OF LESS THAN *** MINUTES.
  '1' LOOP
      END
@
```

APPENDIX C

DEFINITION OF THE PROGRAM VARIABLES

A. Global Variables and Attributes Introduced in the Preamble

ABORTED.CASES: Counter used to tally the number of cases aborted during the year.

AC.ATT.STATUS: Attribute of each air station which indicates what type or types of aircraft are attached. 0 = HH-52A only, 1 = HH-65A only, 2 = both types attached.

AC.TYPE: Attribute of each case which indicates what type of aircraft will be utilized. 0 = HH-52A, 1 = HH-65A, 2 = either HH-65A or HH-52A, depending on availability and location, 130 = HH-52A, with a C-130 acting as escort.

AIR.STATION: Permanent entity, keys storage location for each air station in use.

ANSWERED.CASES: Counter used to tally the number of cases responded to, with no abort, by the system.

AS.LAT: Attribute of each air station, indicating station latitude.

AS.LONG: Attribute of each air station, indicating station longitude.

AS.QUEUE: Set associated with each air station, stores the cases in that station's queue.

AVG.RESP.TIME: SIMSCRIPT II.5 routine which automatically computes the mean of the year's set of response times.

AVG.WAIT.TIME: SIMSCRIPT II.5 routine which automatically computes the mean waiting time for all cases assigned to a station's queue.

CASE: Temporary entity, stores the attributes for each incident until destroyed.

CASE.COUNT: Attribute of each air station, tallies the total number of cases responded to by the unit.

CASE.NUM: Attribute of each case, indicating the number of this case for the year.

CLOSEST.AS: Alpha variable which indicates the closest available air station to a case.

C130.CALLS: Counter for the number of C-130 calls in the year.

DIST.FM.AS: Variable which indicates the straight-line distance from an air station to a case.

DIST.TO.CASE: Variable which indicates the distance from an air station to a case, as calculated by the DISTANCE.TO.CASE routine.

DISTANCE.TO.CASE: Function routine which calculates the distance to a case when the aircraft must follow the coastline from its air station.

DOS: Attribute of each case which indicates the distance offshore.

ENIGMA: Event notice for a search case.

HH.ENDUR: Variable indicating total flight time available for a HH-52A.

HH.FLAG: Variable used to indicate if HH-52As are in use, 0 = No, 1 = Yes.

HH.GRAPH: SIMSCRIPT II.5 routine used to calculate a histogram for each air station of the amount of time the station has 0, 1, 2 or 3 HH-52As not engaged in SAR operations.

HH.RANGE: Variable indicating the maximum radius of flight for a HH-52A without refueling. Maximum distance the craft can fly away from land and be able to return safely.

HH.SPEED: Variable used to indicate the speed of advance for a HH-52A.

LAT: Attribute of each case, indicating its latitude.

LAUNCH: Event notice for a launch.

LNG.MULT: Attribute for each air station, used to convert degrees of longitude into nautical miles. A variable is used to account for the change in the length of degree of longitude as one moves northward.

LONG: Attribute of each case, indicating its longitude.

MR.FLAG: Same as HH.FLAG, used for HH-65As.

MR.GRAPH: Same as HH.GRAPH, used for HH-65As.

MRR.ENDUR: Same as HH.ENDUR, used for HH-65As.

MRR.RANGE: Same as HH.RANGE, used for HH-65As.

MRR.SPEED: Same as HH.SPEED, used for HH-65As.

NAME: Attribute for each air station, alphabetic name of the station.

NDOS: Attribute of each event NOSRCH indicating its distance offshore.

NLAT: Attribute of each event NOSRCH indicating its latitude.

NLONG: Attribute of each event NOSRCH indicating its longitude.

NNOM1, NNOM2 and NNOM3: Attributes of each event NOSRCH indicating the names of the demands of the event.

NO.HH.LAUNCH: Attribute for each air station, used as a counter for the total number of times the station was unable to launch a HH-52A.

NO.MR.LAUNCH: Same as NO.HH.LAUNCH, used for HH-65As.

NO.RESPONCE.CASES: Counter used to tally the number of cases for which the system was unable to respond to with a helicopter.

NOM1, NOM2 and NOM3: Attributes of each case, used to indicate the names of the demands placed upon the system by the case.

NOSRCH: Event notice for a non-search case.

NSEAS: Attribute for each event NOSRCH, indicating the sea state.

NSER1, NSER2 and NSER3: Attributes for each event NOSRCH, Indicating the service times for the demands of the event.

NSEV: Attribute for each event NOSRCH, indicating its severity.

NUM.HH: Attribute for each air station indicating the number of HH-52As available at any time for SAR operations.

NUM.MRR: Same as NUM.HH, used for HH-65As.

NUM.WHO.WAITED: Attribute for each air station which tallies the total number of cases which were queued.

NVIS: Attribute for each event NOSRCH, indicating the visibility on scene.

NWINDS: Attribute for each event NOSRCH, indicating the wind velocity on scene.

RESPONCE.TIME: Variable which measures the amount of time between launch and arrival on scene or at the search location.

RETURN.TO.BASE: Event notice for a return to its base by an aircraft.

RETURNING.TYPE: Attribute for each event RETURN.TO.BASE which indicates what type of helicopter is returning.

RT.GRAPH: SIMSCRIPT II-5 routine used to calculate a histogram of the set of response times generated for each year's run.

SD.RESP.TIME: Same as AVG.RESP.TIME except that the standard deviation is calculated.

SD.WAIT.TIME: Same as AVG.WAIT.TIME except that the standard deviation is calculated.

SDOS: Same as NODS, for the event ENIGMA.

SEAS: Attribute of each case, indicating the sea state.

SEED: Variable used to indicate the random number generator seed in use.

SER.1, SER.2 and SER.3: Attributes for each case, indicating the service times for the case demands.

SEV: Attribute for each case, indicating its severity.
0 = Some danger that personnel or property might be lost.
1 = Personnel or property were in grave danger of loss or were lost.

SNOM1, SNOM2 and SNOM3: Same as NNOM1, etc., for the event ENIGMA.

SORTIE: Variable used to facilitate the passing of case information from one routine to another.

SR.LAT: Same as NLAT, for the event ENIGMA.

SR.LNG: Same as NLONG, for the event ENIGMA.

SSER.1, SSER.2 and SSER.3: Same as NSER.1, etc., for the event ENIGMA.

SSEV: SAME AS NSEV, for the event ENIGMA.

STATION: Attribute for each event RETURN.TO.BASE which indicates which air station the returning helicopter is assigned to.

STATUS: Attribute for each air station, used to facilitate the search for the closest available air station.

STOP.SIM: Event notice for the end of the year/run.

STSEM: Attribute for each event ENIGMA, indicating the total search miles for the event.

SVIS: Same as NVIS, for the event ENIGMA.

SWINDS: Same as NWINDS, for the event ENIGMA.

TIME.IN.QUEUE: Attribute for each case, indicating the time that the case enter an air station's queue.

TSEM: Attribute for each case, indicating the total search miles for the case.

TYPE: Attribute for each case, indicating whether the case is a non-search (TYPE = 1) or search (TYPE = 0) case.

VAR.RESP.TIME: Same as AVG.RESP.TIME except that the variance is calculated.

VAR.WAIT.TIME: Same as AVG.WAIT.TIME except that the variance is calculated.

VIS: Attribute for each case, indicating the visibility for the case.

WAIT.TIME: Attribute for each air station; it measures the amount of time a case has spent in the air station's queue.

WINDS: Attribute for each case, indicating the wind velocity.

X.NUM: Variable used to number all of the cases as they arrive.

B. Variables Introduced in the Routine MAIN

N.AIR.STATION: The number of air stations which will be utilized during a particular run.

C. Variables Introduced in the Routine DISTANCE.TO.CASE

ABS.F: SIMSCRIPT II.5 library routine which takes the absolute value of a number.

CUTOFF: Variable name for the latitude of the point where the coastline turns to the right as depicted in Fig. IV-1.

KNOTS.UP: Variable used to record part or all of the distance, in knots, of a leg of the total flight path.

OUT.KTS: Same as KNOTS.UP.

UP.MILES: Same as KNOTS.UP.

D. Variables Introduced in the ENIGMA Routine

HRS.OUT: Variable used to record the time that it takes a C-130 to arrive on scene.

KNTS.UP: Variable used to record the vertical distance from Air Station Clearwater to a case.

MILEAGE: Variable used to record the straight-line distance from Air Station Clearwater to a case.

OUT.KNTS: Variable used to record the horizontal distance from Air Station Clearwater to a case.

SRCH.HRS: Variable used to record the number of hours the C-130 will take searching on a case.

TOT.HRS: HRS.OUT + SRCH.HRS, total time elapsed until a helicopter is needed.

E. Variables Introduced in the NOSRCH Routine

All local variables utilized in this routine are identical to those used in the ENIGMA routine. TOT.HRS for this routine is the same as HRS.OUT since no searching is involved.

F. Variables Introduced in the LAUNCH Routine

KNOTS.UP: Variable used to record the vertical distance from an air station to a case.

MILEAGE: Variable used to record the straight-line distance from an air station to a case.

OUT.KTS: Variable used to record the horizontal distance from an air station to a case.

PROB.AC.OR: Variable used to record the probability extracted from UNIFORM.F distribution, using the supplied SEED. This variable was then used to determine if an aircraft at the closest available air station was available for SAR operations.

REFUEL: Variable used to record the total number of hours used for refueling, while on a case.

SRCH.TIME: Variable used to record the time that a C-130 will spend searching on a case that a HH-65A was unable to respond on, when HH-52As were also available.

STAR: Variable used to facilitate the search for the closest available air station. It its value gets to zero, then the program realizes that it's run out of possible available air stations.

TIME: Variable used to record the total time spent by a helicopter servicing the demands of a case.

TRANSIT.TIME: Variable used to record the time that it takes for a HH-52A to arrive on scene to assist a C-130 in the servicing of a case.

TRUNC.F: SIMSCRIPT II.5 library routine which truncates an expression or variable leaving only the integer portion.

UNIFORM.F(X,Y,Z): SIMSCRIPT II.5 library routine which generates a random variable which is distributed uniformly between X and Y, utilizing a seed Z. Z = SEED in this model.

G. <u>Variables Introduced in the RETURN.TO.BASE Routine</u>

CRAFT: Is equivalent to the global variable RETURNING.TYPE.

TIME.V: A SIMSCRIPT II.5 global variable which is always equal to the time at which the simulation is at when it is used. Therefore, in this instance, it will always be equal to the time the aircraft returned to base.

APPENDIX D

COMPLETE SIMULATION DATA FOR THE
3 HH-52A, 1 LOCATION SCENARIO

Charleston: Year 1 (139 cases)

ART:	74.88	74.58	74.68
SDRT:	62.36	61.93	62.16
Cases:	124	126	125
Cases NOR:	2	0	1
% of time with 3 HH:	93.8	93.7	93.7
% of time with 2 HH:	5.9	6.0	6.0
% of time with 1 HH:	0.2	0.2	0.2
% of time with 0 HH:	0.0	0.0	0.0
C-130 calls:	16		

% of cases with RT less than 45 minutes: 26.2

% of cases with RT greater than 120 minutes: 17.7

0 cases were queued.

Charleston: Year 2 (141 cases)

ART:	69.99	69.31	69.42
SDRT:	48.05	47.74	47.91
Cases:	126	129	129
Cases NOR:	4	1	2
% of time with 3 HH:	93.6	93.6	93.7
% of time with 2 HH:	6.0	5.9	5.9
% of time with 1 HH:	.3	.4	.4
% of time with 0 HH:	.1	.1	.0
C-130 calls:	15		

% of cases with RT less than 45 minutes: 18.2

% of cases with RT greater than 120 minutes: 11.4

0 cases were queued.

Charleston: Year 3 (163 cases)

ART:	78.45	80.23	78.04
SDRT:	65.31	66.92	65.01
Cases:	152	152	154
Cases NOR:	4	4	2
% of time with 3 HH:	92.3	92.2	92.2
% of time with 2 HH:	7.1	7.1	7.2
% of time with 1 HH:	.5	.5	.4
% of time with 0 HH:	0	.1	.1
C-130 calls:	13		

% of cases with RT less than 45 minutes: 23.6

% of cases with RT greater than 120 minutes: 19.6

Qued Cases:	1	2	2
Average queue time:	66.54	73.25	75.25

Charleston: Year 4 (167 cases)

ART:	70.39	71.83	71.22
SDRT:	58.33	59.27	58.91
Cases:	149	147	150
Cases NOR:	3	5	2
% of time with 3 HH:	93.1	93.2	93.1
% of time with 2 HH:	6.1	6.0	6.1
% of time with 1 HH:	.6	.6	.7
% of time with 0 HH:	.1	.1	.1
C-130 calls:	25		

% of cases with RT less than 45 minutes: 27.1

% of cases with RT greater than 120 minutes: 15.5

0 cases were queued.

Charleston: Year 5 (162 cases)

ART:	79.84	80.42	79.61
SDRT:	64.36	64.53	64.72
Cases:	152	151	150
Cases NOR:	1	2	3
% of time with 3 HH:	92.2	92.2	92.3
% of time with 2 HH:	7.1	7.1	7.2
% of time with 1 HH:	.5	.5	.4
% of time with 0 HH:	.1	.1	.1
C-130 calls:	13		

% of cases with RT less than 45 minutes: 22.2

% of cases with RT greater than 120 minutes: 19.4

0 cases were queued.

Charleston: Year 6 (157 cases)

ART:	74.26	74.18	74.19
SDRT:	57.62	57.43	57.43
Cases:	145	146	146
Cases NOR:	2	1	1
% of time with 3 HH:	92.7	92.6	92.7
% of time with 2 HH:	6.6	6.7	6.6
% of time with 1 HH:	.6	.6	.7
% of time with 0 HH:	0	0	0
C-130 calls:	13		

% of cases with RT less than 45 minutes: 25.3

% of cases with RT greater than 120 minutes: 15.7

0 cases were queued.

Charleston: Year 7 (178 cases)

ART:	79.59	80.07	79.89
SDRT:	67.52	67.78	67.90
Cases:	165	165	166
Cases NOR:	2	2	1
% of time with 3 HH:	91.5	91.5	91.5
% of time with 2 HH:	7.4	7.4	7.4
% of time with 1 HH:	.9	.9	.9
% of time with 0 HH:	.1	.1	.1
C-130 calls:	20		

% of cases with RT less than 45 minutes: 27.1

% of cases with RT greater than 120 minutes: 19.5

0 cases were queued.

Mayport: Year 1

ART:	66.19	66.21	66.12
SDRT:	21.83	21.74	21.68
Cases:	124	125	126
Cases NOR:	2	1	0
% of time with 3 HH:	94.3	94.3	94.2
% of time with 2 HH:	5.4	5.4	5.5
% of time with 1 HH:	.2	.2	.2
% of time with 0 HH:	.1	.1	.1
C-130 calls:	16		

% of cases with RT less than 45 minutes: 12.4

% of cases with RT greater than 120 minutes: 0.7

0 cases were queued.

Mayport: Year 2

ART:	60.39	60.38	60.42
SDRT:	22.19	22.10	22.24
Cases:	129	130	128
Cases NOR:	1	1	2
% of time with 3 HH:	93.8	93.7	93.9
% of time with 2 HH:	5.9	5.9	5.9
% of time with 1 HH:	0.2	0.2	0.2
% of time with 0 HH:	0.1	0.1	0.0
C-130 calls:	15		

% of cases with RT less than 45 minutes: 19.8

% of cases with RT greater than 120 minutes: 0.7

0 cases were queued.

Mayport: Year 3

ART:	66.99	66.67	67.02
SDRT:	22.46	22.13	22.35
Cases:	154	151	152
Cases NOR:	2	5	4
% of time with 3 HH:	92.8	92.9	92.9
% of time with 2 HH:	6.5	6.4	6.5
% of time with 1 HH:	0.5	0.5	0.5
% of time with 0 HH:	0.2	0.2	0.1
C-130 calls:	13		

% of cases with RT less than 45 minutes: 12.9

% of cases with RT greater than 120 minutes: 0.7

3 cases were queued with an average waiting time in the queue of 43.36 minutes.

Mayport: Year 4

ART:	65.56	65.62	65.63
SDRT:	21.30	21.43	21.43
Cases:	152	150	150
Cases NOR:	0	2	2
% of time with 3 HH:	93.4	93.4	93.5
% of time with 2 HH:	5.9	5.9	5.8
% of time with 1 HH:	0.6	0.6	0.6
% of time with 0 HH:	0.1	0.0	0.1
C-130 calls:	25		

% of cases with RT less than 45 minutes: 13.1

% of cases with RT greater than 120 minutes: 0.6

0 cases were queued.

Mayport: Year 5

ART:	64.45	64.39	64.67
SDRT:	23.67	23.76	23.47
Cases:	151	150	152
Cases NOR:	2	3	1
% of time with 3 HH:	92.9	93.0	92.9
% of time with 2 HH:	6.5	6.4	6.5
% of time with 1 HH:	0.4	0.4	0.4
% of time with 0 HH:	0.1	0.1	0.1
C-130 calls:	13		

% of cases with RT less than 45 minutes: 16.5

% of cases with RT greater than 120 minutes: 1.3

0 cases were queued.

Mayport: Year 6

ART:	63.85	64.03	64.09
SDRT:	22.38	22.46	22.52
Cases:	146	146	145
Cases NOR:	1	1	2
% of time with 3 HH:	93.4	93.3	93.4
% of time with 2 HH:	5.9	6.0	5.9
% of time with 1 HH:	0.5	0.5	0.5
% of time with 0 HH:	0.1	0.1	0.1
C-130 calls:	13		

% of cases with RT less than 45 minutes: 16.4

% of cases with RT greater than 120 minutes: 0.0

0 cases were queued.

Mayport: Year 7

ART:	65.91	66.13	65.65
SDRT:	25.90	26.15	25.38
Cases:	165	165	165
Cases NOR:	2	2	2
% of time with 3 HH:	92.2	92.3	92.3
% of time with 2 HH:	6.8	6.7	6.8
% of time with 1 HH:	0.8	0.8	0.7
% of time with 0 HH:	0.1	0.1	0.2
C-130 calls:	20		

% of cases with RT less than 45 minutes: 16.2

% of cases with RT greater than 120 minutes: 1.3

0 cases were queued.

Savannah: Year 1

ART:	48.38	49.45	50.01
SDRT:	45.48	45.99	46.12
Cases:	127	129	127
Cases NOR:	2	0	2
% of time with 3 HH:	95.0	94.8	94.9
% of time with 2 HH:	4.6	4.7	4.7
% of time with 1 HH:	0.2	0.2	0.2
% of time with 0 HH:	0.1	0.2	0.1
C-130 calls:	16		

% of cases with RT less than 45 minutes: 59.1

% of cases with RT greater than 120 minutes: 12.1

1 case was queued with a waiting time in that queue of 472.89 minutes.

Savannah: Year 2

ART:	39.21	39.00	38.60
SDRT:	37.63	37.57	37.13
Cases:	129	130	128
Cases NOR:	1	0	2
% of time with 3 HH:	94.8	94.8	94.9
% of time with 2 HH:	4.9	4.9	4.8
% of time with 1 HH:	0.2	0.2	0.1
% of time with 0 HH:	0.0	0.0	0.1
C-130 calls:	15		

% of cases with RT less than 45 minutes: 68.2

% of cases with RT greater than 120 minutes: 6.8

0 cases were queued.

Savannah: Year 3

ART:	47.30	48.27	47.40
SDRT:	47.46	48.67	47.61
Cases:	154	152	153
Cases NOR:	2	4	3
% of time with 3 HH:	93.6	93.6	93.6
% of time with 2 HH:	6.0	5.9	5.9
% of time with 1 HH:	0.2	0.3	0.3
% of time with 0 HH:	0.1	0.1	0.1

C-130 calls: 13

% of cases with RT less than 45 minutes: 64.6

% of cases with RT greater than 120 minutes: 13.3

0 cases were queued.

Savannah: Year 4

ART:	45.64	45.68	45.05
SDRT:	44.88	44.94	44.34
Cases:	152	151	150
Cases NOR:	0	1	2
% of time with 3 HH:	94.4	94.4	94.4
% of time with 2 HH:	5.0	5.0	5.1
% of time with 1 HH:	0.5	0.5	0.4
% of time with 0 HH:	0.1	0.1	0.1
C-130 calls:	25		

% of cases with RT less than 45 minutes: 61.4

% of cases with RT greater than 120 minutes: 11.4

0 cases were queued.

Savannah: Year 5

ART:	47.24	46.44	47.01
SDRT:	48.46	48.28	48.38
Cases:	150	152	151
Cases NOR:	3	1	2
% of time with 3 HH:	93.8	93.7	93.7
% of time with 2 HH:	5.7	5.8	5.8
% of time with 1 HH:	0.3	0.3	0.4
% of time with 0 HH:	0.1	0.1	0.1
C-130 calls:	13		

% of cases with RT less than 45 minutes: 63.1

% of cases with RT greater than 120 minutes: 14.1

0 cases were queued.

Savannah: Year 6

ART:	41.87	42.08	42.06
SDRT:	42.90	42.97	42.98
Cases:	147	146	146
Cases NOR:	0	1	1
% of time with 3 HH:	94.2	94.2	94.2
% of time with 2 HH:	5.4	5.3	5.4
% of time with 1 HH:	0.4	0.4	0.4
% of time with 0 HH:	0.0	0.0	0.0
C-130 calls:	13		

% of cases with RT less than 45 minutes: 67.5

% of cases with RT greater than 120 minutes: 9.3

0 cases were queued.

Savannah: Year 7

ART:	50.87	50.32	49.93
SDRT:	48.99	49.01	48.81
Cases:	165	165	165
Cases NOR;	2	2	2
% of time with 3 HH:	93.0	93.0	93.0
% of time with 2 HH:	6.1	6.2	6.2
% of time with 1 HH:	0.7	0.7	0.7
% of time with 0 HH:	0.1	0.1	0.1
C-130 calls:	20		

% of cases with RT less than 45 minutes: 60.5

% of cases with RT greater than 120 minutes: 14.2

0 cases were queued.

NOTE: As seen with the previous runs, with locations in SAVANNAH, MAYPORT and CHARLESTON, changing SEED did not affect the outcome to any large degree so this was not done for the BRUNSWICK runs.

Brunswick:	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
ART:	52.60	43.55	52.27	51.64	50.85	48.60	54.33
SDRT:	28.41	25.34	30.33	27.03	30.35	27.09	30.44
Cases:	124	130	154	150	150	146	166
Cases NOR:	2	0	2	2	3	1	1
% of time with 3 HH:	94.9	94.5	93.4	94.1	93.7	94.0	92.9
% of time with 2 HH:	4.8	5.2	6.1	5.3	5.8	5.4	6.2
% of time with 1 HH:	0.1	0.1	0.3	0.6	0.4	0.4	0.7
% of time with 0 HH:	0.0	0.1	0.1	0.0	0.1	0.1	0.1
C-130 calls:	16	15	13	25	13	13	20
% cases w/RT < 45:	48.8	64.1	51.0	45.4	54.8	53.8	48.1
% cases w/RT > 120:	3.1	1.5	6.2	2.6	5.5	4.1	5.6
Cases qued:	0	0	0	0	0	0	0

APPENDIX E

Complete Simulation Data for the 3 HH-52A, 2 Located in Savannah and 1 Located in Other Locations Scenario

Savannah (2 HH-52As), Brunswick (1 HH-52A):

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
ART:	40.28	31.23	40.52	39.71	38.47	34.27	41.68
SDRT:	35.25	29.84	38.54	34.32	38.58	34.67	37.26
Cases:	88/37	92/35	107/45	116/34	109/43	107/37	120/45
Cases NOR:	5/9	6/14	8/13	5/13	4/13	4/13	6/14
% of time Sav has 2 HH-52As:	97.4	96.7	96.2	96.2	96.2	96.5	95.7
% of time SAV has 1 HH-52A:	2.5	3.2	3.6	3.7	3.6	3.4	4.2
% of time Sav has 0 HH-52As:	0.1	0.1	0.2	0.1	0.2	0.1	0.1
% of time Bru has 1 HH-52A:	97.9	98.4	97.6	98.2	97.8	97.9	97.2
% of time Bru has 0 HH-52As:	2.1	1.6	2.4	1.8	2.2	2.0	2.8
C-130 calls:	16	15	13	25	13	13	20
% of cases w/RT < 45:	60.1	74.6	66.6	62.2	68.9	73.6	63.0
% of cases w/RT > 120:	4.7	3.8	9.5	4.5	6.7	6.1	8.6
Cases Qued Sav:			3/127.93	1/29.66	1/40.14		1/98.85
Cases Qued Bru:	0	1/149.11	2/135.96	2/45.12	3/200.83	1/249.54	1/62.2
No response:	1	3	4	2	1	3	2

Savannah (2 HH-52As), Mayport (1 HH-52)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
ART:	39.54	31.23	37.58	37.08	35.28	33.11	39.30
SDRT:	33.45	25.62	30.85	27.30	30.93	31.17	32.61
Cases:	95/29	99/29	116/37	118/32	110/42	114/29	123/42
Cases NOR:	6/9	6/8	8/9	7/8	5/10	6/12	7/12
% of time Sav has 2 HH-52As:	97.2	96.6	95.9	96.4	96.5	96.3	95.6
% of time Sav has 1 HH-52A:	2.7	3.3	3.9	3.5	3.3	3.6	4.3
% of time Sav has 0 HH-52As:	0.1	0.1	0.2	0.1	0.2	0.1	0.1
% of time May has 1 HH-52A:	98.2	98.5	98.1	98.1	97.7	98.4	97.6
% of time May has 0 HH-52As:	1.8	1.5	1.9	1.9	2.3	1.6	2.4
C-130 calls:	16	15	13	25	13	13	20
% of cases w/RT < 45:	62.5	73.3	67.6	61.5	70.1	76.2	64.2
% of cases w/RT > 120:	4.7	1.5	2.0	1.3	2.7	3.4	3.7
Cases Qued Sav:	0	0	5/50.64	1/29.66	0	0	1/98.85
Cases Qued May:	0	0	1/161.88	1/1.51	4/144.54	1/194.88	1/7.54
No response:	2	2	3	2	1	4	2

Savannah (2 HH-52As), Daytona (1 HH-52A)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
ART:	36.09	31.66	33.80	33.80	32.40	32.18	38.35
SDRT:	34.11	27.96	31.01	27.93	31.76	30.19	32.64
Cases:	99/25	104/25	117/35	120/30	120/32	119/25	127/38
Cases NOR:	6/9	7/6	10/8	8/6	4/10	6/9	9/10
% of time Sav has 2 HH-52As:	96.8	96.4	95.8	96.3	95.9	95.8	95.4
% of time Sav has 1 HH-52A:	3.1	3.5	3.9	3.6	3.9	4.0	4.5
% of time Sav has 0 HH-52As:	0.1	0.1	0.2	0.1	0.2	0.1	0.1
% of time Day has 1 HH-52A:	98.7	98.8	98.4	98.5	98.5	98.8	97.9
% of time Day has 0 HH-52As:	1.3	1.2	1.6	1.5	1.5	1.2	2.1
C-130 calls:	16	15	13	25	13	13	20
% of cases w/RT < 45:	69.5	73.3	74.0	68.6	74.1	75.7	66.0
% of cases w/RT > 120:	5.4	1.5	2.7	2.6	3.4	4.1	4.9
Cases Qued Sav:	0	0	4/138.48	1/29.66	0	0	1/98.85
Cases Qued Day:	0	0	1/259.22	0	2/225.88	1/97.54	0
No response:	2	1	4	2	1	3	2

APPENDIX F

Complete Simulation Data for the 2 HH-52A/1 HH-65A,
1 Location Scenario (Savannah)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
ART:	55.07	37.27	49.93	53.83	56.24	42.23	69.77
SDRT:	91.24	38.03	52.08	87.32	89.89	45.13	130.41
Cases:	124	125	142	150	141	139	157
Cases NOR:	0/7	1/9	0/12	0/14	0/8	0/15	0/11
% of time Sav has 2 HH-52As:	95.2	95.3	94.1	94.9	94.2	94.7	93.7
% of time Sav has 1 HH-52A:	4.7	4.5	5.6	4.7	5.5	5.2	5.7
% of time Sav has 0 HH-52As:	0.1	0.2	0.3	0.4	0.3	0.1	0.6
% of time Sav has 1 HH-65A:	99.6	99.4	99.2	99.0	99.4	99.4	98.9
% of time Sav has 0 HH-65As:	0.4	0.6	0.8	1.0	0.6	0.6	1.1
C-130 calls:	2	2	3	6	1	3	1
% of cases w/RT < 45:	64.5	74.4	66.9	64.7	63.1	69.8	60.5
% of cases w/RT > 120:	14.5	6.4	16.2	14.6	16.3	10.1	17.8
Cases Qued:	0	1/32.8	1/92.17	0	0	0	0
No response:	5	7	9	8	7	12	10

APPENDIX G

Complete Simulation Data for the 2 HH-52A/1 HH-65A System,
2 Located in Savannah and the HH-65A Located in Other Locations

Savannah (2 HH-52As), Mayport (1 HH-65A)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
ART:	41.31	29.31	35.24	39.39	37.92	28.26	54.77
SDRT:	81.89	21.79	34.02	75.58	78.06	24.80	124.43
Cases:	92/42	95/42	112/49	114/49	104/55	113/43	116/53
Cases NOR:	0/7	1/9	0/11	0/11	0/7	0/8	1/15
% of time Sav has 2 HH-52As:	97.0	96.6	96.2	96.4	96.7	96.5	95.6
% of time Sav has 1 HH-52A:	2.9	3.3	3.7	3.4	3.2	3.4	4.3
% of time Sav has 0 HH-52As:	0.1	0.1	0.1	0.2	0.1	0.1	0.1
% of time May has 1 HH-52A:	98.4	98.3	97.5	97.4	97.4	97.9	97.3
% of time May has 0 HH-52As:	1.6	1.7	2.5	2.6	2.6	2.1	2.7
C-130 calls:	2	3	1	5	0	2	4
% of cases w/RT < 45:	66.6	77.1	76.6	70.3	70.3	78.6	69.3
% of cases w/RT > 120:	2.3	0.8	3.3	3.2	2.0	2.0	7.3
Cases Qued Sav:	0	0	1/95.46	0	0	0	0
Cases Qued May:	0	0	5/191.10	1/20.44	2/169.93	1/87.95	2/126.41
No response:	0	1	0	0	0	0	2

Savannah (2 HH-52As), Brunswick (1 HH-65A)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
ART:	41.48	27.08	35.06	39.02	39.28	30.43	55.59
SDRT:	83.82	23.72	34.15	76.61	79.30	29.89	125.06
Cases:	88/48	85/52	103/57	106/57	98/60	103/53	110/59
Cases NOR:	0.8	1/10	1/13	0/11	0/11	0/10	1/15
% of time Sav has 2 HH-52As:	97.4	97.0	96.7	96.6	97.0	96.6	95.7
% of time Sav has 1 HH-52A:	2.5	2.9	3.2	3.2	2.7	3.2	4.2
% of time Sav has 0 HH-52As:	0.1	0.1	0.1	0.2	0.3	0.2	0.1
% of time Bru has 1 HH-65A:	97.9	97.9	97.1	97.3	97.1	97.6	97.1
% of time Bru has 0 HH-65As:	2.1	2.1	2.9	2.7	2.9	2.4	2.9
C-130 calls:	0	3	2	5	2	1	4
% of cases w/RT < 45:	67.4	77.1	72.5	69.6	69.6	79.3	65.1
% of cases w/RT > 120:	4.6	0.7	3.4	3.2	2.7	2.6	7.4
Cases Qued Sav:	0	0	1/95.46	0	1/217.06	0	0
Cases Qued Bru:	1/30.7	0	0	0	1/220.98	1/123.09	2/155.17
No response:	0	1	1	0	0	0	2

Savannah (2 HH-52As), Daytona Beach (1 HH-65A)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
ART:	40.69	33.42	41.07	37.42	36.63	30.65	53.94
SDRT:	82.24	27.53	76.52	40.74	77.81	27.30	124.00
Cases:	94/40	102/36	117/46	119/42	111/48	122/34	124/45
Cases NOR:	0/3	0/4	0/10	0/7	0/6	0.8	1/15
% of time Sav has 2 HH-52As:	96.9	96.3	96.3	95.8	96.5	96.1	95.2
% of time Sav has 1 HH-52A:	3.0	3.5	3.5	3.9	3.3	3.8	4.6
% of time Sav has 0 HH-52As:	0.1	0.1	0.2	0.2	0.2	0.1	0.2
% of time Day has 1 HH-52A:	98.5	98.3	97.5	97.8	97.6	98.2	97.7
% of time Day has 0 HH-52As:	1.5	1.7	2.5	2.2	2.4	1.8	2.3
C-130 calls:	2	3	5	1	0	2	4
% of cases w/RT < 45:	73.6	74.2	70.3	76.6	77.0	80.7	73.0
% of cases w/RT > 120:	2.3	2.3	2.5	4.6	2.0	1.3	6.1
Cases Qued Sav:	0	0	0	3/97.69	0	0	0
Cases Qued Day:	0	0	1/73.88	3/139.09	2/131.29	1/27.36	2/105.95
No response:	0	0	0	0	0	0	2

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